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Zeos tops our list of fastest-growing companies
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FPGA profits attract a crowd of hungry vendors
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A CAHNERS PUBLICATION

Electronic Business®

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPA... WORLDWIDE

MAY 18, 1992

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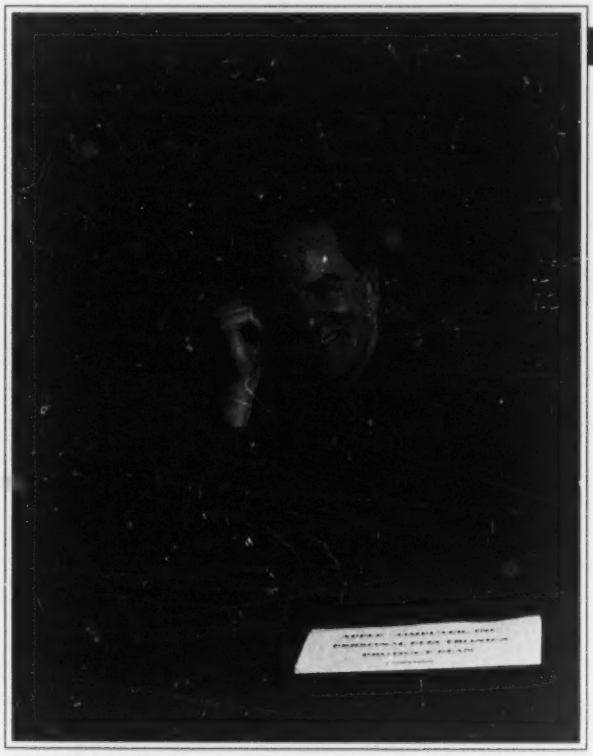
Electronic Business

VOLUME 18, NUMBER 8 | FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES WORLDWIDE | MAY 18, 1992



Cover photo by Rick Smolan

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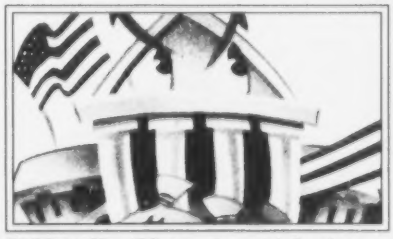

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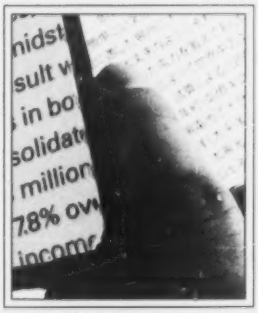

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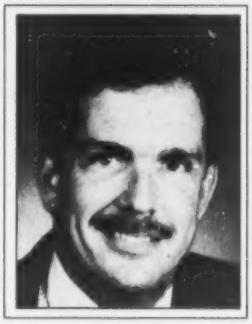
Keeping score on industry teamwork

Born of hard times and patriotic fervor, electronics industry consortia were supposed to be America's answer to the nationally sponsored R&D juggernauts rolling in from Europe and the Pacific Rim. How well have Sematech, Semiconductor Research Corp., and Microelectronics and Computer Corp. fulfilled our expectations?



Associate editor David Webb

Not well, if you consider enlistment of wholesale participation: Only 60% of the nation's electronics companies own shares in the three organizations, and only 36% of the CEOs surveyed in our exclusive ELECTRONIC BUSINESS/Ernst & Young survey plan to increase consortium participation.

There are signs of progress, however. In our cover story, senior editor Peter Burrows reports that, beyond merely surviving, Sematech, SRC, and MCC have defined more practical roles and have begun putting solid business principles into practice. The numbers of researchers on silicon-based development projects have grown, and plans for new fab sites have given way to a focus on precompetitive generic research.

There's even progress in Washington, although the current administration still has trouble dealing with "the competitiveness thing." Congress is moving toward easing antitrust restrictions on joint R&D programs. Contributing editor Willie Schatz explains how the National Cooperative Manufacturing Act will help companies who want to pool their research assets and describes how to seek government approval under the act's provisions.

For comparative purposes, London-based editor Barbara Berkman provides an in-depth look at the successes and weaknesses of Jessi, Sematech's European counterpart.

There may be hope for a U.S. resurgence in processor technology, but what about consumer electronics? With the U.S. holding only 13% of worldwide production, the market might look like a lost cause. Then again, maybe not. Associate editor David Webb in San Jose reports that the folks who brought you the laser printer and the graphical user interface are planning a comeback. In the future envisioned by Apple Computer's John Sculley and Hewlett-Packard's John Young, U.S.-made "information appliances"—handheld computers and VCR-size transceivers—will provide consumers with a combination of interactive television, on-line information services, and sophisticated personal computing.

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BPA ABP

TAX POLICY

The IRS wants to extend its reach to U.S. foreign subsidiaries

BY NEXT YEAR, it could be tougher for U.S. companies to use foreign subsidiaries to achieve tax breaks. The IRS wants to close loopholes in the tax code that allow U.S. parent companies to report lower income and thus pay less taxes.

Here's how the practice works: A U.S. chip maker could license a design to its Taiwan subsidiary. The subsidiary might build the chip at a cost of $5 each, then "sell" it back to the parent for $50 each. If the parent sells the chip for $60, it pays U.S. taxes only on the $10 profit. The $45 profit of the subsidiary is subject to taxation by Taiwan only, often at a much lower rate.

U.S. companies have sidestepped taxes by recording these high buyback costs from subsidiaries, while the subsidiaries record higher profits out of reach of the IRS. The specific loophole results from the vagueness of U.S. tax regulations regarding intangible costs, such as chip design.

The IRS wants to crack down on companies it says are cheating—ostensibly by reporting minimum profits on goods "bought back" from offshore subsidiaries with a high percentage cost of intangibles. Because U.S. electronics companies often ship out parts for offshore assembly, the industry is a prime target of increased IRS scrutiny.

"There is a great deal of uncertainty about how one should structure relations with their foreign subsidiaries," says David Swenson, partner at Baker & McKenzie, a Washington law firm working with the IRS to reinterpret the regulations. Confirms Ray Rossi, manager of external tax affairs at Intel Corp., "The regs don't lend themselves to reality."

The generally accepted standard for determining the fair costs and profits between a mother company and its offshore subsidiary is the "arm's length" rule. It states that costs are determined as if subsidiaries were independent suppliers no closer than "arm's length" to avoid blatant profit record gerrymandering. The Treasury Department will reportedly seek a stricter interpretation of the arm's length rule.

"One significant thing about the new regulations is that the IRS hasn't been particularly successful in litigating these issues. The view is that the [proposed interpretations] of the regs will tilt the playing field in favor of the IRS," says Tom Gibson of Price Waterhouse.

Companies doing business in Europe, for example, would be effectively double taxed—once by the host country, and once by the U.S.

"There's no question that these [proposals] add to the complexity of complying with tax laws. It can also put strain on treaty relationships with other countries," Gibson says.

Curiously, the same tax issue has led to charges that foreign firms are exploiting the laws by charging their U.S. subsidiaries inflated prices for goods made in Japan and elsewhere, so the subsidiary is taxed only on the small mark-up to the end-user in the U.S. Most of the profit is kept overseas where tax rates are more favorable. Rep. J. J. Pickle, (D-Tex.), says foreign companies are cheating the U.S. Treasury out of $30 billion a year using such loopholes.

The American Electronics Association has not yet determined the full impact of the proposed changes but created a committee in April to examine the issue, says Ed Hatcher, director of tax policy at the AEA in Washington, D.C. At first glance, though, he's not optimistic. "The proposed regs . . . are very close to being a disaster," he says.

—David Webb in San Jose

TECHNOLOGY

Top 10 technologies on IS managers' shopping lists

TEN technology areas—as identified by more than 1,750 information systems (IS) managers in a recent spending survey—are booming, even as IS departments try to cut

costs. If you're not already a vendor in these, take another look.

Most of the IS departments polled by Cahners Publishing's *Datamation* magazine and the Business Research Group (BRG) in Newton, Mass., are developing LANs, incorporating existing mainframes and minicomputers into the networks as servers. Only 18% reported mainframe-based applications development this year.

The shift to LANs is in response to the stringent cost-control measures adopted at most IS departments this year. The average budget increase is a paltry 4%, according to the IS managers responding to the survey questionnaire in January.

The 10 hottest technologies of 1992

(% of sites reporting implementation plan)

Local area networks	46
Client-server architecture	43
Graphic user interface and windowing software	37
Bar-code scanners and software	35
Relational data base management software	33
Desktop computers	33
Laptops	29
RISC workstations	27
Minicomputers	26
Fiber	23

Source: 1992 MIS Strategic Planning Study by Datamation/BRG

Other money-saving technologies being adopted by a significant number of companies include bar-code processing to improve the accuracy and timeliness of inventory management and retail sales and relational database management systems to improve management's ability to identify product and marketing trends (see table). One pleasant surprise for some vendors: strong demand for the embryonic handheld computers. More than 10% of the survey respondents indicated that they were developing applications based on the recently announced technology, though most of the products have yet to ship.

For more information about the market prospects of more than 40 hardware and software technologies included in the questionnaire, contact the BRG at (617) 630-3900.

—Larry Marion

MARKETS

Is there a risk of DRAM déjà vu all over again?

SINCE LAST summer, average selling prices of dynamic RAMs have plummeted, raising concerns that the industry may be setting itself up for another DRAM recession.

"There is a huge amount of DRAM overcapacity at the moment, and that same situation drove the industry into its worst recession in the mid-'80s," says Gordon E. Moore, chairman of Intel Corp.

The price for 1-megabit DRAM chips fell from about $4.75 in July 1991 to about $4 this April, according to statistics from *Electronics Purchasing* magazine (a Cahners publication). Some sources claim the 1-Mbit chips can be bought today for as little as $3 to $3.50. Meanwhile, insiders say, 4-Mbit DRAM chips that sold for close to $20 last summer can now be had for just $11 or $12.

Do 1-Megabit DRAM prices herald another glut?

Despite these price drops, some in the industry question whether the cause is production overcapacity, which could trigger a recession. They argue the cheap DRAMs may have resulted from Far Eastern manufacturers "blowing off" bloated inventories. DRAM maker Micron Technologies apparently thinks the "blowing off" has gone to an extreme. In late April, Micron filed dumping charges against three Korean DRAM manufacturers.

Dumping questions aside, the changing economic scene makes it unlikely that the industry will see a repeat of the mid-1980s. DRAM production facilities then were built at a rate that far outpaced the market demand. Japanese manufacturers were enjoying zero cost of capital thanks to the rate of the yen's appreciation. Return on capital wasn't part of the business or capacity planning process.

Today, though, Japanese manufacturers are carrying very heavy debt loads and are facing the prospect of refinancing their paper at higher interest rates.

"Japanese companies have cut back substantially on their [production] capacity additions," says one source. These economic factors are likely to persist through the 1990s, he believes, so he doubts there will be a recurrence of the 1980s' DRAM debacle.

—Dwight B. Davis

COMPETITIVENESS

Who's world-class and what they're doing to stay there

ONLY ABOUT 20% of electronics manufacturing companies rate themselves as "world class" or approaching world-class status, according to a study recently released by Deloitte-Touche Manufacturing Consulting Services.

The study provides a strategic profile of 169 North American electronics companies and was based on

responses from 872 executives. Nearly all of those companies claiming world-class status also reported they are still trying to improve. High on their hit lists: supplier and customer relationships, human resources, and technological leadership.

Pursuit of organizational excellence in the electronics industry is expanding into a broad-based initiative, says Ron Chapman, national director for the high-technology group at D&T. Whereas high product quality was once sufficient definition of world class, excellent customer service and other factors are now necessary to gain that distinction. The average rates of improvement in delivery time and internal quality were greater for world-class companies than for those who did not consider themselves world class.

"World-class companies are using programs like quality function deployment to bring the voice of the customer into their design process," Chapman says. QFD also allows manufacturers to plan for two or more product changeovers simultaneously, shortening time to market and increasing customer satisfaction.

Computer integrated manufacturing is another factor that separates the world-class players from their competitors. About 33% of the executives polled said they had no plans for CIM environments and 46% are planning CIM, but only 5% have implemented it in their manufacturing environments.

—Hugh Willett in San Jose

MARKETS

Semi materials market nears $10 billion

Worldwide consumption ($ millions)

	1991	1992	1993	1994
Wafer fab materials	$5,019	$5,342	$5,770	$6,341
Silicon wafers	2,090	2,215	2,414	2,700
Other substrates	264	279	314	352
Photo masks	1,120	1,202	1,250	1,320
Photoresists	248	263	284	305
Wet chemicals	444	468	506	546
Gases	603	640	700	780
Deposition materials	250	275	302	338
Packaging materials	$4,151	$4,344	$4,812	$5,215
Leadframes	1,239	1,313	1,431	1,603
Ceramic packages	951	1,037	1,308	1,410
Encapsulation resins	472	500	545	610
Bonding wire	334	354	385	431
Thick film pastes	205	195	190	190
Cerdip	197	193	189	185
Seal lids	234	222	220	220
Headers and cans	100	100	95	90
Other	419	430	449	476
Total	$9,170	$9,686	$10,582	$11,556

Y130=$1

Source: Electronic Materials Report

THESE LITTLE BITS of metal and plastic don't get much fanfare, but the semiconductor materials market is approaching a $10 billion business. Sales of these materials came to $9.2 billion in 1991 and should reach $9.7 billion in 1992, according to Electronic Materials Report from Rose Associates in Los Altos, Calif. That puts the materials content at about 16.5% of the total $58 billion value of semiconductor devices expected to be sold worldwide in 1992.

Epitaxial wafers are the bright spot in an otherwise slow market for silicon wafers. Growth in leadframes will be in surface mount and etched frames. Leadframes for surface mounted devices are expected to see 20% growth for the next several years; sales of etched leadframes are expected to jump 19% in 1992, to surpass 20% of the total leadframe market for the first time.

—Paula Doe in Japan

TECHNOLOGY

Big brother (the high-tech version) is watching you

DID YOU EVER worry that your contribution to high-tech innovation would come back to haunt you? It has.

Welcome the "Electronic Attendance Board" by inventor James Shields of Haddon Heights, N.J., a device that automatically identifies the entry or the exit of individual employees.

The idea, says Shields, is to keep track of which employees are in the building, which are out on work assignments, and which workers are out on a break or at home—all with an electronic board.

The inventor will not reveal how his electronic people-watcher works because the patent is still pending. Shields got the idea for the product from his experience as a salesman. "I'd wait five minutes on the phone for someone and the secretary would come back to tell me the guy was on vacation," says Shields. "So I saw the need for something like this in the business world."

Perpetual latecomers and sneaky early departers don't have to worry for now; the high-tech attendance taker isn't in production yet. Shields is still looking for someone to license the idea for manufacturing. The editors at ELECTRONIC BUSINESS concur that this idea is a case of high tech run amok. But then editors are commonly known to be particularly tough employees to track down. . . and we want to keep it that way.

—E. B. Baatz

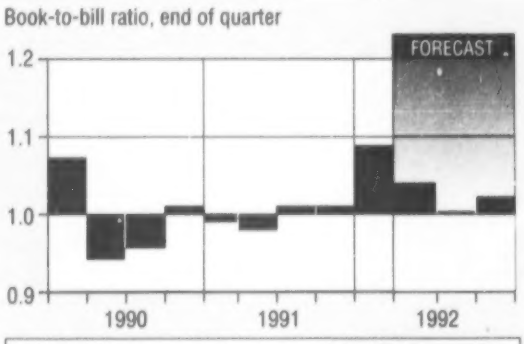
DISTRIBUTION

The recovery is here at last, say distributors

IF FIRST QUARTER distributors' sales and orders are any indication of the future for electronics sales, our forecasts are right on track. Cahners Economics expects distributors' shipments to push up 11.6% this year and orders to swell 13.4%. Unlike last year when sales and orders quickly petered out, this time expect double-digit growth to hold firm as end-market demand for components flourishes. In particular, U.S. semiconductor sales through distributors will also post strong gains, rising 10.5% this year.

In the first quarter of 1992, distributors' new orders jumped 15.2% above the previous year's first-quarter level, the biggest such increase since 1990. Shipments also rose in the first three months of 1992, but at a more modest 9.6% growth rate.

The book-to-bill ratio for the nation's largest distributors has managed to hover above parity in each of the last eight months. In particular, the ratio hit an unexpected high of 1.11 in January, dropped to a respectable 1.04 in February, then rebounded to 1.09 in March. That performance is significantly better than the first quarter of either 1991 or 1990.



(Index: May 1980 =100)					FORECAST			
Orders	326	316	346	378	378	359	378	408
Shipments	324	315	334	350	363	358	371	383
	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
		1991				1992		1993

Source: National Electronic Distributors Assn.; Forecast: Cahners Economics

For electronic component and equipment manufacturers, the distributor data are more than just dry statistics. Remember, distributors are a leading indicator for the rest of the electronics industry. So start preparing for the next recovery.

—Julie Handelman-Sagan

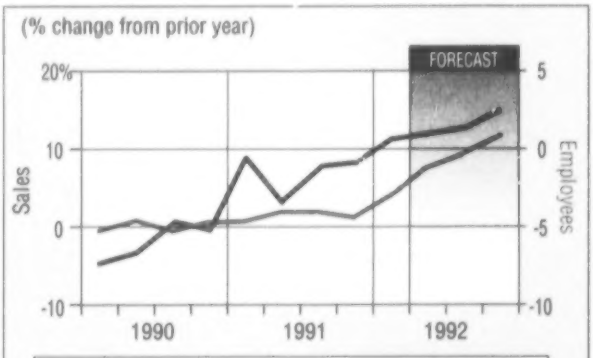
SEMICONDUCTORS

Chip sales rise briskly, but more layoffs are likely

U.S. CHIP manufacturers will likely see stronger gains this year after a disappointing 1991. Cahners Economics expects semiconductor sales in North America to reach $17.4 billion in 1992, 13.4% above 1991 sales. New orders should advance 14.7% this year to $18 billion.

Unlike last year, when the risk to the forecast was on the downside, the risk now appears to be all on the upside. Low interest rates and stronger investment in high-tech capital equipment should fuel demand for chips this year.

First-quarter data is right on target with these forecasts. In the first quarter of 1992, semiconductor sales climbed 12.2% above the previous year's level, while orders rose 13%. These were the best quarterly growth rates the industry has seen since mid-1989. The book-to-bill ratio swung between only 1.11 in February to 1.08 in March, somewhat disappointing relative to early 1991 levels. These data can be interpreted as relatively solid numbers, however, and do not indicate a bookings bust later this year.



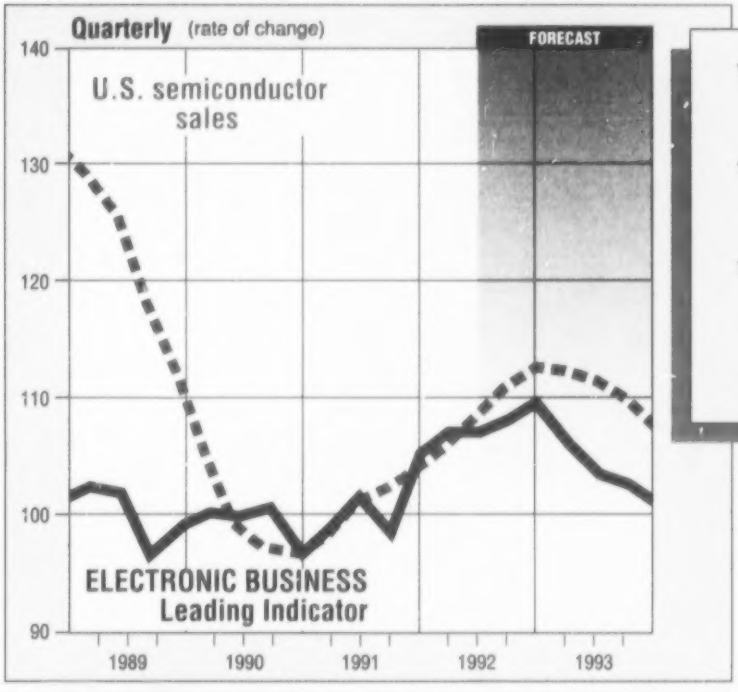
($ billions)					FORECAST			
Orders	4.15	3.66	3.98	4.45	4.73	4.23	4.64	5.04
Sales	3.83	3.86	3.90	4.25	4.32	4.39	4.48	4.73
	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
		1991				1992		1993

Source: Semiconductor Industry Association; Forecast: Cahners Economics

Although sales are enjoying a rebound now, employment isn't likely to pick up any time soon. In fact, following on the heels of 3% or more annual declines in employment in each of the past three years, employment by U.S. chip makers is likely to fall another 2% this year. The industry has already lost 41,000 jobs from its peak employment level of 262,400 in August of 1988.

—J. H. S.

ELECTRONIC BUSINESS Leading Indicator

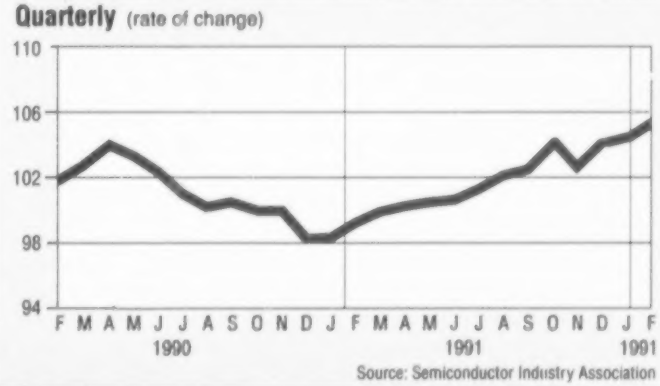


Indicator levels off in March

The ELECTRONIC BUSINESS Leading Indicator (EBLI) averaged 107.2 during the first quarter of 1992—a much better number than the 99.5 mark registered last year during the same period. Perhaps the most encouraging news in March is the continued expansion of semiconductor production workers' weekly hours—an indicator that may portend a resumption of new hiring in the year ahead. Look for the EBLI to remain near its present level for the next few months before regaining speed in the second half of 1992 along with the general economy.

—John Farrell

Semi production workers' day slowly lengthens



Source: Semiconductor Industry Association

	Latest month	Previous month	Year ago	1991 average
ELECTRONIC BUSINESS Leading Indicator (rate of change, Mar.)	106.3	106.4	101.8	101.5
U.S. semiconductor bookings ($ millions, 3-month average, Mar.)	$1,528	$1,477	$1,383	$1,311
Weekly hours of semiconductor production workers (monthly average, Feb.)	42.7	42.3	40.9	41.1
Electronic components lead time index (1977 = 100, Mar.)	90.2	88.4	78.0	87.5
S&P's semiconductor stock price index (1970 =10, monthly average, Mar.)	88.0	91.5	70.6	68.5
Change in electronic components inventories ($ millions, SA, Feb.)	$57	-$108	-$207	-$53
Contracts and orders for plant and equipment ($ billions, SA, Feb.)	$34.6	$35.4	$37.3	$35.0

SA = seasonally adjusted; all other data are not seasonally adjusted

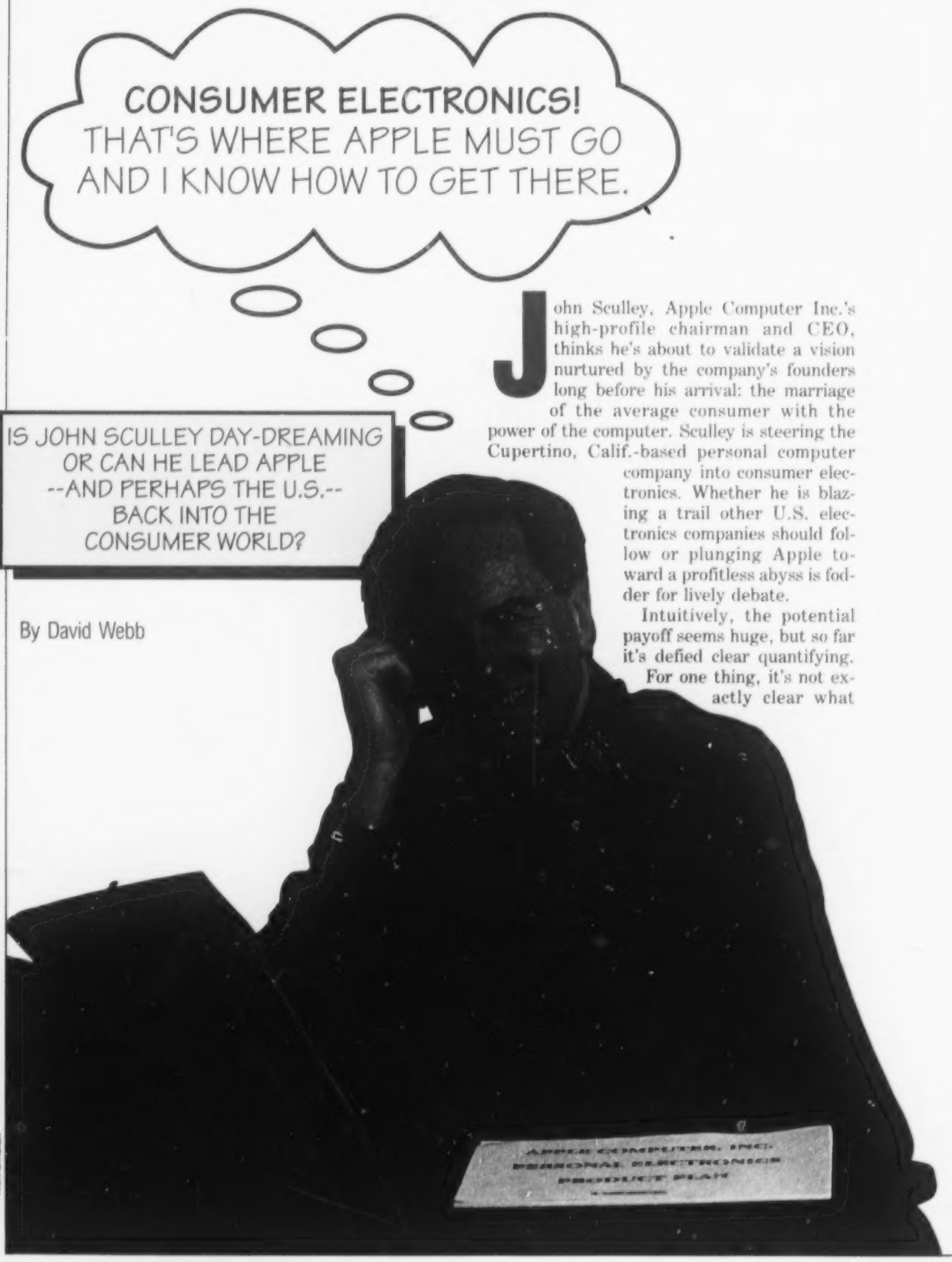
Sources: Semiconductor Industry Association, Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, Commerce Dept., Bureau of Economic Analysis, Cahners Economics

EBLI is a weighted composite of six statistics that lead activity in the electronics industry. To obtain a complimentary background paper, contact Michele Cooper, Cahners Economics, 275 Washington St., Newton, MA 02158-1630, USA; telephone (617) 630-2119; fax (617) 630-2100

COVER STORY

IS JOHN SCULLEY DAY-DREAMING OR CAN HE LEAD APPLE --AND PERHAPS THE U.S.-- BACK INTO THE CONSUMER WORLD?

By David Webb



Rick Smolan

John Sculley, Apple Computer Inc.'s high-profile chairman and CEO, thinks he's about to validate a vision nurtured by the company's founders long before his arrival: the marriage of the average consumer with the power of the computer. Sculley is steering the Cupertino, Calif.-based personal computer company into consumer electronics. Whether he is blazing a trail other U.S. electronics companies should follow or plunging Apple toward a profitless abyss is fodder for lively debate.

Intuitively, the potential payoff seems huge, but so far it's defied clear quantifying. For one thing, it's not exactly clear what

the products will be. For another, the marketing channel is unfamiliar. That said, many observers say the stampede by computer makers into this new world will soon start in earnest, and each new entrant will seek a unique proprietary advantage.

Apple wants to leverage its graphical user interface, which catapulted the Macintosh to success into "information appliances." These include something Sculley calls "PDAs," or Personal Digital Assistants—handheld computers with communications capabilities—as well as conventional desktop and notebook-size Macintoshes. Apple also plans to license home-grown software that will handle everything from easy programming for VCRs to ordering pizza through an interactive television network.

How the consumer market stacks up

Production by category for 1990 ($ billions)

Product	Europe	U.S.	Japan	Total world
Color TVs	$7.2	$5.1	$6.1	$27.0
Black & white TVs	0.0	0.0	0.0	1.4
Car audio systems	1.1	2.3	3.1	10.1
VCRs	2.2	0.1	7.4	12.0
Video cameras	0.1	0.0	5.0	5.6
Videodisk equipment	0.0	0.0	0.8	0.8
CD players	0.6	0.0	1.2	2.3
Tapes	2.4	3.0	3.3	10.0
Other	2.2	0.8	8.6	18.8
Total	**$15.8**	**$11.3**	**$35.5**	**$88.0***

*1991(est.)= $93 billion

Source: Electronics International Corp.

These are big changes, both for Apple and for the computer industry. Apple is already modifying its business plan to accommodate a consumer focus. Sculley recently restructured his sales organizations, adding a group dedicated to developing a consumer market sales effort.

"I think this is one of those rare moments when the industry is taking advantage of the change in the technology base," Sculley says. "It's a great opportunity for U.S. companies to make the most of [the growing use of] digital information."

Software expertise is clearly Apple's entree to the "new" market, but other U.S. strengths are in hardware as well. They include, for example, digital-signal processors, high-end microprocessors, mixed-signal ICs, and multichip packaging. One challenge is to identify which markets to attack first.

Apple is definitely not chasing the traditional consumer market. With recessionary blues being sung all around the world, conventional consumer electronics manufacturers are having a tough time selling traditional boxes such as VCRs, TVs, stereos, and CD players, analysts say. "Consumer product companies as we've known them aren't making money anymore," says London-based BIS Strategic Decisions analyst David Mercer. Future opportunities for electronics vendors are in versions of those things that are not only computerized—as many are today—but also optimize a growing digital communications infrastructure.

The first wave of these new information appliances is expected late this year and early next year from Apple, Hewlett-Packard, and their partners. Interestingly, although Apple and HP will deliver very different products, they both will try to capitalize on a convergence of digital processing with new communications capabilities. Until recently, telephones, television, and radio were strictly based on analog technologies.

Even now, the telecommunications infrastructure of the U.S. is undergoing a conversion to digital in both the huge terrestrial-based telecom network as well as radio-frequency (RF), cellular, and satellite communications networks.

Information appliances would combine RF communications, computer processing power, and user-friendly software to make portable and easier-to-use products for just about anyone. The products, in concept, would:

- be lightweight, use a generic microprocessor, an assortment of ASICs, and up to one megabyte of memory;
- have a screen and a pen stylus or touchscreen interface on a Walkman-size device;
- be able to communicate with other systems via a wireless single-chip modem with subscription information services that provide banking, shopping, and news as well as unit-to-unit communications services;
- likely cost under $500, plummeting to less than $200 over time.

Because the critical path to this new market is paved with requirements for advanced software for accessing and manipulating digital information, U.S. companies have a chance to establish an early lead and to maintain domi-

nance in what is a new category of consumer goods.

"There are several interesting things happening here," says Jon Gayle, an analyst at Alexandria, Va.-based market research firm Information Workstation Group. "Vendors are taking consumer electronic [products] like televisions and leveraging their use, essentially making information appliances with easy user interfaces. It's happening because of the displacement of analog by digital."

The U.S. Federal Communications Commission, in fact, will soon define HDTV standards that will have a dramatic impact on the rate of digital communications infrastructure development worldwide. Digital broadcasting—a likely component of the U.S. HDTV standard definition—will speed the proliferation of digital information and the acceptance of an entire new set of applications. Real-time or instantaneous viewer response to television advertisements is one example. Whether that's a benefit or a setback may depend on your buying habits and bank account, but whatever your view of its social value, it would not be possible using only analog-signal technology. Neither would ordering a pizza via the television screen and having it delivered in 30 minutes.

"We really want to become the Microsoft of the consumer [personal electronics] market," Sculley says unabashedly

However big the market for these devices and services turns out to be, one challenge will be reaching an unfamiliar customer base. Both Apple and HP enter the consumer world with mostly computer-marketing experience. It's true that HP has had some consumer experience from selling its calculators, but they are typically expensive, feature-rich calculators targeted for college students and scientists, not the four-function, balance-your-checkbook crowd. Likewise, Apple is a neophyte to the rough-and-tumble environment of consumer electronics. It officially announced its entry into the consumer market last December and did so with just a hazy outline of what it intends to do beyond making Macintosh desktop computers "for the rest of us." Some industry watchers are skeptical about Sculley's rather civilized approach and if it can work in the cutthroat consumer world.

"Apple's very broad-brush approach makes good copy, but it probably isn't a good business plan," says analyst Mark Stahlman at Alex. Brown & Sons Inc. He is critical of Apple's assumption that the convergence of communications, computer, and consumer technologies along with established consumer distribution networks will conveniently place operating-system software vendors such as Apple in a position of strategic importance. Stahlman quickly notes that Apple has only "produced talk" to date, despite financial commitments to new ventures with IBM, Sony Corp., and Sharp Corp. He claims those aren't product relationships but technology development relationships that are based on personal computer development. Unlike PCs, consumer electronics tend to be tightly integrated application-specific products; they aren't broadly functional the way PCs are, and they command a lower price as a result. "The challenge for Apple and everyone else is to think through new business [opportunities] beyond PC-oriented uses," Stahlman says.

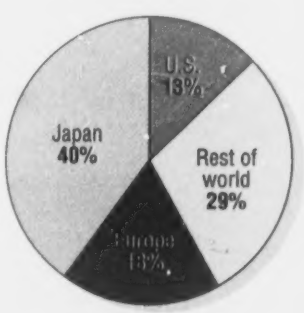
"The key here is really software-intensive digital communications," says market analyst Walter Miao, vice president of technology at Link Resources Inc. "Apple is looking at the communications angle very intensely." Without the promise of a growing digital communications infrastructure, Miao says, Apple would be stunted in its quest to make its presumed handheld PDAs a commodity item.

Sculley seems to agree. "The biggest opportunity for PDAs are those applications built around communications," he says. Televisions and especially telephones will be "reinvented in the '90s," largely because analog information formats will be replaced by digital.

Apple's strategy provides at least one model

U.S. trails badly in consumer electronics

(U.S., Japan, and Europe produced 71% of the world's consumer electronics in 1990)



Source: Electronics International Corp.

for U.S. companies eager to compete in the consumer electronics market, which has for so long been dominated by non-U.S. companies.

Sculley, for example, readily acknowledges Apple will need a partner with consumer manufacturing and marketing experience to help design and build small, handheld PDAs. In this case, packaging design and manufacturing are critical issues. Sculley hopes to find that expertise in Apple's partnership with Sony, the giant manufacturer of consumer electronics goods renown for its expertise at cramming circuitry into small, attractive packages. The joint venture with Sharp is expected to produce "wizard-like" personal organizers with a Macintosh graphical user interface and stripped-down version of the Mac's operating system.

A company entering this market will almost surely have to rely on an established partner,

HP dips a toe into consumer waters

HEWLETT-PACKARD is another U.S. company warily entering the consumer electronics world. Its early strategy is to avoid the cutthroat margins so typical of commodity items and to concentrate on more profitable and pricey business.

"We're trying to be careful about conveying the perception that we are 'going after' the consumer market," says HP spokesperson Larry Sennett. "We'll make whatever the consumer will buy and whatever we can sell at the right price point," he says.

HP plans to build a VCR-size computerized transceiver that would be a primary television interface with interactive capabilities. In simpler terms, the box would be a computer that runs software to process real-time interaction with bank accounts, grocers, pizza restaurants, advertisers, game shows, or sporting events, among others. HP has partnered with Reston, Va.-based TV Answer Inc., which developed the interface software and will also be the licensing hub of a nationwide network of metropolitan service area providers. The service providers will broadcast these interactive services into users' homes through the HP-built unit.

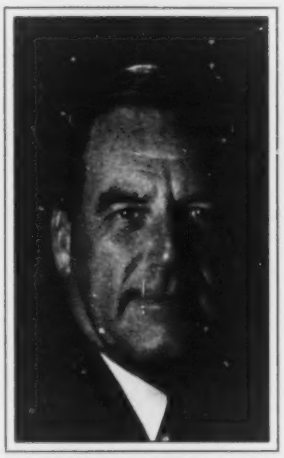
To appreciate how large HP expects this interactive TV service market to become, consider that HP is ramping up two manufacturing sites—one in Roseville, Calif., and the other in Singapore—capable of producing 1.5 million units yearly. These facilities should be ready before the end of next year, although HP says it won't begin production until a year after the Federal Communications Commission issues the first licenses to service area providers. That isn't expected to happen until this fall.

Some analysts think HP, despite its calculator/consumer market experience, will have difficulty penetrating the interactive TV gadget business, which depends heavily on marketing by service providers."The TV Answer device will require marketing in channels different from those used to sell calculators. I don't see [HP] catering to Joe Six-Pack," says Walter Miao, a market analyst at Link Resources Inc.

Sennett doesn't "see it as a K Mart type of product for a while," at least the first year or two. Eventually, he says, TV Answer will wind up with the same channel progression as Nintendo, which was graduated over a 10-year period from niche electronics and toy retailers into the mainstream mass-marketer channel. Sennett said HP will probably start with computer superstores such as Fry's Electronics and electronics retailers such as Circuit City.

HP already has competitors in the interactive TV market, including Mountain View, Calif.-based Interactive Network Inc. and Frox Inc. of Sunnyvale, Calif. Interactive Network is providing an interactive TV service to subscribers in the Sacramento and San Francisco areas with plans to go into other major metropolitan areas this year. Users pay $200 for a broadcast "control box" similar to HP's and a $15 monthly service charge. The service enables viewers to play along with TV game shows such as "Jeopardy" and "Wheel of Fortune" and sporting events such as football, baseball, and basketball. Unlike HP's TV Answer service, Interactive Network, at least for now, is purely an entertainment medium.

Likewise, Frox's system is solely for the purpose of home entertainment, albeit with computerized features that make it as easy to use as possible. However, it's not cheap. For a mere $10,000 to $50,000, a consumer can buy a Sparc RISC microprocessor-based Frox entertainment system with full digital TV (not HDTV), laser video-disk player, digital audio-tape player, compact disk player, and fiber-optic wired speakers. □



Hewlett-Packard CEO John Young is concentrating on profits as HP enters the consumer market

according to Sculley, whether it's a manufacturer, marketer, distributor, or technology developer. "It's unrealistic to expect any one company to create a successful PDA business [as a hardware and software developer, manufacturer, and marketer]," Sculley says.

U.S. vendors will probably focus on one or two functions. The most likely scenario will be U.S. vendors using offshore manufacturing expertise to build hardware while developing and licensing software to run it, Sculley says. Much of that software development could come out of the publishing and entertainment industries, not conventional computer software application houses, he adds. Even more interesting is the likelihood that telecommunications companies such as the Regional Bell Operating Companies will play an important role in the application development for these new devices.

Apple has reorganized its once geographically segmented sales organization into four units: one targeting large customers and institutions such as schools and government agencies; another targeting small businesses; a third targeting K-12 education; and the fourth targeting consumers.

"A customer [-oriented sales organization] shift would have taken place, anyway," contends Tim Bajarin, president of Creative Strategies Research International Inc. in Santa Clara, Calif. Unlike conventional PC distribution for business applications, the mass-market channels need a faster, more precise response time to orders. "Apple is in the best position to capitalize on the PDA beyond the business market," says Bajarin. "They are the only company in the computer or consumer world that understands what's happening."

Bajarin cites four reasons why that is so:

- Apple understands the trend of analog-to-digital conversion of key industries, particularly communications;
- it understands the role of operating systems for so-called "hidden computers";
- it knows that consumer product architectures need to be scalable from a software standpoint;
- and it realizes the need to transcend PC application thinking into consumer-oriented mindsets.

"I don't sense the same level of understanding from Microsoft" about the personal electronics market, Bajarin adds.

Apple's consumer strategy is really a subset of what Sculley calls a "personal electronics" market strategy. Apple intends to help design handheld PDAs on which its operating system software will run with an easy-to-use graphical user interface—Apple's forte—included. It will then license its software and architectures to established consumer market manufacturers, that would build and market products to consumers. This is a big break from the past, when Apple was loath to part with proprietary technology in either hardware or software. Many observers think Apple could have captured a much larger chunk of the PC world had it been willing to license its architecture.

"We really want to become the Microsoft of the consumer [personal electronics] market," Sculley says unabashedly. "The biggest opportunity for us [to do that] is PDAs." Apple also intends to make such devices itself for a non-consumer market of vertical business applications.

Sculley explains Apple's PDA channel strategy as a three-pronged approach: First, mass merchandisers will distribute Apple and Apple-licensee PDAs; second, Apple will use its existing channels for sales of business-oriented PDAs; and third, Apple will sell into the information services market through or with service providers. That's an ambitious plan, and success is far from assured.

Apple is also dabbling in the more traditional entertainment market with General Magic in Mountain View, Calif. Apple has an equity stake along with Sony in the new venture. General Magic won't comment specifically about what it's doing, but analysts say the company is creating a handheld wireless portable interface for computers. Interactive TV would be one product made possible by these devices. Combined with hardware designed by General Magic and built by Sony, Apple supposedly intends to make its interactive TV interface as common as cable TV in U.S. homes. This is a strategy similar to Sculley's plan for PDAs. The most important use of the wireless technology, however, will be as a "window" to a remote desktop using a pen stylus and cellular or radio-frequency link, something analyst Sheridan Tatsuno of Neoconcepts Inc. in Rio Del Mar, Calif., calls a digital "communicator." Neither Apple nor General Magic will disclose when products will be available. □

CONSORTIA

Are they getting better?

Yes. It's been a painful process, but U.S. R&D consortia are finally producing results

By Peter Burrows

Consider the state of research and development in the U.S. The traditional R&D drivers—the Defense Department, the central labs of companies such as AT&T and IBM, and universities—are all withering under funding pressure. Shrinking profit margins are forcing many companies to focus their in-house efforts on applied projects with short-term payback. Add to that the skyrocketing capital requirements for long-term product development and manufacturing capacity, and it's easy to understand why even the largest players are teaming up with competitors to help share costs and disperse risk.

The big question is how best to cooperate. One controversial solution in the U.S. has been R&D consortia, in which private companies share ideas, personnel, and capital to develop technology to spur the competitiveness of all. "How else can you have a staff of Ph.D.s doing research that you get to direct for a small fraction of the cost, without even having to worry about hiring and firing and all the rest?" asks Terry Krinke, manager of quality and technology for Control Data Corp.'s government systems manufacturing division.

Yet, while that may sound great, R&D consortia haven't really caught on. Only 60 of the 20,000-plus electronics companies in the U.S. are full shareholders in the industry's three major efforts—the Semiconductor Research Corp. (SRC), the Microelectronics and Computer Technology Corp. (MCC), and Sematech—and controversy, lack of member commitment, and a scarcity of clear results have marred these efforts to varying degrees.

In fact, only 36% of 455 CEOs surveyed recently by ELECTRONIC BUSINESS and Ernst & Young expect to increase their participation in consortia over the next five years—the lowest percentage of the nine different partnering schemes listed in the survey.

Do the poor early results and widespread negative feedback mean the U.S. should dump consortia as a tool for competitiveness? The answer is no—or at least not yet. Having survived difficult infancies, Sematech, SRC, and MCC are now stable, maturing organizations. While their dreams have been scaled back, their efforts are starting to pay off, and all three are working to implement key lessons learned in their formative years. Some specifics:

- SRC, which just celebrated its 10th birthday, continues to impress members with its ability to coordinate the nation's university research into silicon-based technology. It now funds about half of all such research in the nation, with over 100 research contracts at 72 different universities;
- MCC, also created in 1982 to main-

tain the nation's lead in computer technologies, has taken strong steps to counter the claim that it is incapable of delivering commercially useful results. Payoffs from its more ambitious projects are still years away, but a rising tide of software tools and new production and packaging technologies are flowing from its Austin facilities;

• Sematech, after a series of midcourse corrections, has settled into a more realistic strategy to improve the semiconductor manufacturing infrastructure that has quelled much of the criticism it suffered during its first five years. Members say these efforts have enabled them to buy more U.S.-made equipment than they expected. Intel, for example, bought 50% of the equipment for a new fab from U.S. sources rather than the 30% it had expected, while Motorola bought over 80% American for its new MOS-11 fab instead of the 25% it had planned for.

WHAT'S CHANGED? For starters, these consortia had to overcome some deep-seated biases within the American psyche. Rather than assume the product development burden of their members, they have had to limit their scope to more generic R&D. Cooperation between competitors to develop products for mutual benefit and for the good of the country sounds fine on paper but didn't translate well in a nation of capitalism purists. The privileges of membership—federal funding and the increased ability to influence industry direction—clashed with America's devotion to self-betterment and level playing fields. The founding fathers' wide-eyed love of big goals heightened these tensions. Sematech, at least initially, thought it was on a Messianic mission to save an industry.

All three are responding to these biases, building uniquely U.S. versions of consortia in the process. They ask their members to share, but only so much and only when it doesn't put them in head-to-head battle with each other in the marketplace. Plenty of kinks remain to be worked out, but progress has been made, as a look at all three reveals.

SRC, based in Research Triangle Park, N.C., was from the start best positioned for success. Its goals were more modest and less likely to raise member concerns about losing proprietary knowledge. Rather than save the U.S. semiconductor industry, which was Sematech's much-heralded charter, or maintain the nation's dominance in computer technology, which was MCC's reason for being, SRC had a more bounded purpose. It hoped to coordinate and promote research on silicon-based technology and to build up the stream of new ideas and engineers flowing from universities into the chip business.

So far, SRC seems to have delivered. In 1982, the shift of U.S. university research programs from silicon to other materials left only 25-or-so graduate students working on silicon-based projects. Today, there are more than 600 students involved in SRC-funded projects, and close coordination with SRC member companies has helped faculty focus on areas of the highest commercial interest. Perhaps best of all, a 500-person mentoring program has helped member companies capture the fruits of this research. Advanced Micro Devices Inc. in Sunnyvale, Calif., for example, recently picked up modelling technology from the University of California at Berkeley that significantly sped the adoption of advanced photolithographic processes.

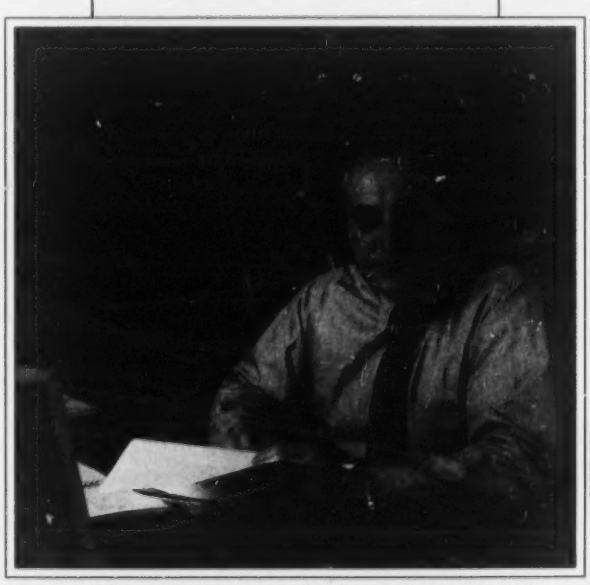
"The only place research into silicon-based technology is increasing is in our universities, and that's because of SRC," says SRC president George Sumney. "Plus, we now have the strongest link between industry and the universities that exists anywhere in the world."

Observers confirm this bullish assessment. "We have invested about $2 million in SRC and $20 million in Sematech, but we get about the same value from each," says Court Skinner, R&D director for National Semiconductor Corp. IBM has hired more than 70 engineers who have participated in SRC projects, SRC sources say.

Even consortia-bashers, such as Cypress Semiconductor president T. J. Rodgers, give praise: "SRC would be one of the first I would join if I had the money to invest."

Much of the credit goes to SRC's decision to minimize rather than maximize its assets and focus. "From the start, we decided to use existing teams, capabilities, and facilities wherever they existed," says vice president and chief scientist William Burger, who spent 20 years with R&D contractor Research Triangle Institute before joining nascent SRC in 1982. "We didn't want to create our own empire."

With only 12 full-time staffers working from a humble office, SRC is a model of efficiency—vastly different from 700-plus person Sematech, which lobbied hard in the early days for funding to build a state-of-the-art fab of its own. Moreover, SRC's modest government funding—just 5% of its $37 million annual budget—lets it



Allen Weiss

"Research into silicon-based technology is increasing only at our universities, and that's because of SRC," says SRC president George Sumney

avoid the public limelight and enables it to work harder and less self-consciously to serve its members' needs. Sematech, on the other hand, must constantly justify the national benefit of the $100 million it gets from the DOD's Defense Advanced Research Projects Agency (DARPA) each year. MCC is somewhere in the middle, getting about 20% of its $55 million budget from competitively won Defense Department contracts.

DURING the past two years, MCC and Sematech have begun adjusting to the realities that made SRC a success. New leadership is partly responsible for the change. Since Craig Fields left DARPA to head MCC and William Spencer became Sematech CEO in mid-1990, both organizations have de-emphasized broad mission statements and now focus on more narrowly defined goals:

- MCC recently announced a 10-year-plan that focuses primarily on two areas—a high-value electronics division that develops packaging, interconnect, and display technology, and an enterprise integration division dedicated to building a global data-highway and accompanying networking and database technologies to bring departments and companies closer together;
- Sematech now seeks to improve the quality and reliability of the equipment and materials its members rely on—a far cry from its original charter. "Sematech's first plan was to actually build DRAMs to learn about manufacturing and then grind them up at the end," scoffs Arita Prabhakar, director of microelectronics technology at DARPA, who describes relations with Sematech in 1988 as "hostile." "They're a million miles from that now, and I'm delighted with how they've shifted."

Consortia comes up last in CEOs' partnering plans ...

(% expecting to increase activity in next five years)

Marketing agreements	81%
Technology licensing	77
Joint product development	77
Distribution agreements	72
Comprehensive joint ventures	58
Research partnerships	58
Manufacturing agreements	58
Equity investments	54
Consortia	**36**

... and here's what consortia CEOs are doing about it

Focus on precompetitive R&D. Rather than develop next-generation product technologies, Sematech and MCC are working to improve the supplier infrastructure and to develop standards. This widens their appeal, and makes them less threatening to companies who feared sharing proprietary product technology.

Coordinate more, invent less. By pushing actual R&D out to the members' labs, consortia save money and improve the likelihood that findings are actually commercialized.

Act like a company. With members demanding a quantifiable return-on-investment, consortia are instituting business-like processes and procedures to increase and concretely prove their worth.

Source: ELECTRONIC BUSINESS/Ernst & Young

Both MCC's and Sematech's new agendas are increasingly focused on precompetitive R&D—areas that offer industry-wide benefit without providing new product technology with which members can directly compete. This occurred for good and bad reasons.

On the down side, both consortia learned the hard way that U.S. companies are not ready to share key technologies. Sematech's early history illustrates the point. With Japan in the process of stealing huge chunks of the U.S. chip market, many Sematech insiders say the consortia got off to a fast start on its original plan to develop processes to build 64-Mb DRAMs and other critical components. IBM and AT&T donated key process technologies, and founding fathers such as Robert Noyce and Charles Sporck convinced Congress to provide the funding to build its own fab to support the effort.

"There was a sense of desperation in the industry that convinced us to take a leap of faith and look at it from a patriotic standpoint," says LSI Logic Corp. vice chairman George Wells. "We knew we'd have problems working with competitors, but we all decided to get our shoulders behind the same wheel and not let the Japanese eat our lunch any more."

Problems soon overwhelmed that idea. Members began to refuse to share their best people or proprietary know-how. Multifaceted partnerships between members and foreign competitors, such as AT&T's links with NEC and Texas Instrument Inc.'s joint work with Hitachi Ltd., exacerbated the problem. Those that were willing to share reportedly demanded intellectual property protection assurances that stymied efforts to make use of their contributions. It was a Catch-22.

The shift to precompetitive R&D has eased member's concerns about revealing too much to competitors—either foreign or domestic. On the positive side, this change has extended the potential benefits of consortia to the industry at large.

RECOGNIZING THIS, management at MCC and SRC have changed their dues structures to allow companies to have non-voting participation in particular projects at reduced rates. Small companies can now get involved in MCC projects for as little as $5,000, down from $20,000 in the past—and can even pay with stock if they lack the cash. SRC's lowest fee is just $500. Full equity shares in MCC cost $250,000, plus additional annual dues for particular projects. Annual fees for SRC members range from $65,000 to $2.8 million. Sematech has no plans to alter its dues structure, which requires a minimum annual fee of $1 million.

Most importantly, the move to generic research lets them focus on the issues that most help members, consortia executives say. Rather than provide technology to build this year's better mousetrap, the argument goes, why not provide the core

capabilities to help members provide any mousetrap faster, better and more efficiently. "The name of the game is no longer to develop some unique product and keep it from the competition for 10 years," says MCC CEO and president Fields. "The real key is being able to provide a little better quality, reliability, time-to-market, cost, and product diversity. It's sustaining the small business advantages that leads to competitive success rather than failure."

With that in mind, Fields has steered MCC in a variety of new directions. One is to develop a data communications highway called EINet and related services to enable business partners to speed up their interactions and to cooperatively develop products. MCC is also increasing its focus on standards development, and is making itself available to members to do market trial studies to try out new products with other members before ramping up for the general market.

But that's not all. Like Sematech, MCC is working to create a network of relationships between companies at various levels of the food chain to ensure a healthy industry infrastructure for its shareholders. Where a stable U.S. supplier does not exist, MCC has provided venture funding to fill the gap; in three instances where no vendor existed, it has spun-off internal groups.

While these are new wrinkles for consortia, they fit into MCC's dream, says chief operating officer and executive vice president Alan Salisbury. "To create a technological engine of change for our members, and to be a proactive force that helps knock down barriers in markets by creating standards and healthy suppliers."

Still, the move to precompetitive R&D is a retrenchment—making it more clear than ever that consortia will not be a panacea for industry woes. As such, many original consortia members, wary of efforts that don't directly relate to their plans, are demanding proof of the benefits.

LSI Logic, unsatisfied with the evidence, chose to resign from Sematech in January. A key gripe was Sematech's direct investment in critical suppliers. "Its a long stretch from developing world-class process technology to being a venture capitalist for struggling equipment-makers," says LSI Logic's Wells.

Unlike their pioneering predecessors, the current generation of executives at Sematech and MCC have made a high priority of proving their organization's real worth.

"My sense is that Sematech was formed out of a sense of panic fueled by a burst of patriotism," says Sematech chief administrative officer Frank Squires, another former Xerox executive who followed Spencer to Sematech last April.

MCC's dream: to spur members' competitiveness, drive standards, create healthy suppliers, and be an "engine of change," says COO Alan Salisbury

"Chip companies were in a free fall and so took it as an article of faith that [forming a consortia] was the right thing to do—to do what the Japanese and the Europeans did. Now that we've stopped the market-share erosion and have some years under our belt, members are very appropriately looking at their return from a financial perspective."

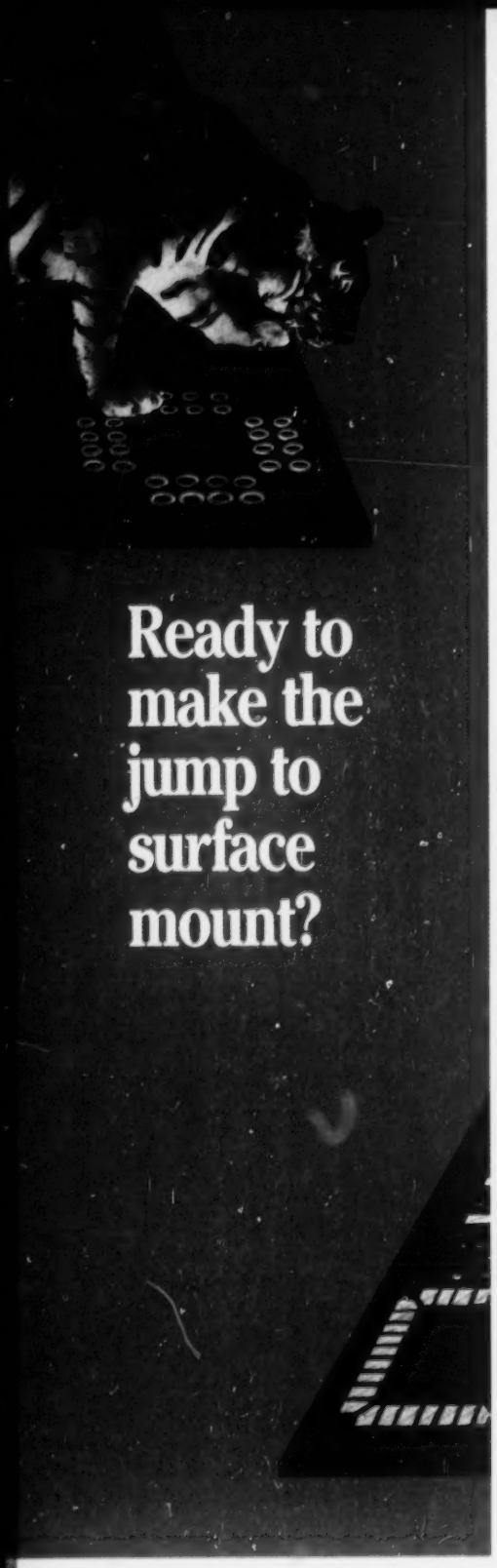
With that in mind, Sematech plans to deliver a customized return-on-investment analysis to each member by year's end. While Spencer estimates that most members now receive a positive but meager ROI—and that does *not* consider such intangibles as improved infrastructure or industry cooperation—his goal is to provide an annual return approaching 10% by 1994. "If Sematech is not providing a reasonable benefit, then the members should not stick with us," he says.

To ensure it does bring benefit, Spencer has made internal operations the number one focus for 1992. "Cost efficiency and urgency have not been high enough on the list." Already, he claims that efforts have improved Sematech's on-time performance from 50% last spring to over 85% at the end of the year. Agrees LSI Logic's Wells, "Sematech is a much more businesslike place under Spencer. Timetables are very tight, and there's a sense that it's being run like any good company should be run."

Fields has attempted to do the same for MCC. "There may have been some theological fervor at the beginning, like there is at the start of anything new," he says. "But if there's one message I try to drill home, it's that I don't want anyone to be in MCC if they think it's a charity or because they 'like consortia.' I want them to be in MCC because they are going to get business benefit."

Another measure of success for consortia is membership growth. By that measure, MCC must be doing something right. While it has attracted only two new full shareholders in the past two years, the number of non-voting associate members—lower dues for narrowly restricted participation in specific projects—has swelled from six to more than 50 since 1988. Also, long-dormant members are considering becoming active again. One example is Control Data Corp., which had wound down its involvement in MCC projects from 3 assignees in 1985 to zero by 1988 but which may now send some people again, says CDC's Terry Krinke.

Whether employees of CDC—or anyone else—will want the job is another matter. Attracting key people to consortia has long been a problem. Accepting such an assignment has meant removing oneself from the corporate ladder—a problem quite apart from reluctance by companies to send their top staffers. "There are clearly cases where members send warm bodies to meet their



contractual obligations," says one MCC full-time employee.

At one point in 1983, former chief Bobby Ray Inman publicly complained about the poor quality of the assignees being sent to fill the seven vice president spots and admitted to rejecting most of those suggested. Fields says those days are gone. "Yes, I would like more assignees, but I have no problem with the quality of those I do get," he says. "Even in these recessionary times, our people get jobs within 15 minutes of leaving here."

Sematech was formed out of a sense of panic and a burst of patriotism

Consider the case of Advanced Micro Devices, a Sematech founder. It was much criticized for not looking out for assignees' careers in the early years. Today, AMD provides a mentor for each of its 20 assignees. "There's a waiting list from internal groups that want to hire them," says AMD senior vice president and Sematech board member Gene Connor.

Many companies have replaced the bulletin-board approach to finding willing assignees with a more proactive selection process designed to get the right person for the job. Most Sematech members also have assigned full-time employees to transfer technology within their companies, as well as mentors for each assignee; that way, the company gets to take advantage of what the assignee has learned, and the assignee feels less out of the loop with the home office. Other members are still in transition. "I don't think we put enough into it," says a source at National Semiconductor. "It's taken a while for people to get interested, but it's coming around. We have 20 people down there, but we still have to pay our 'sweat dues.' "

"You need people at the consortia, but you also need people back here who are ready to receive that technology," says Sharon Lipp, Digital Equipment Corp.'s senior manager for technology development programs, including SRC, MCC, and Sematech. Like other consortia users, DEC has a wide portfolio of "trust building" measures to ensure that consortia's output are exploited, such as newsletters, regular phone calls with managers, quarterly meetings of all assignees and managers, and periodic site visits. Harris Corp. requires all of its plant managers to visit Sematech yearly to learn what technology might be useful.

Sematech is working on its end to make itself more useful. Its Quality Assignee program, for example, helps members determine when and where to send assignees so that they get the most out of the project. Rather than assign employees to arbitrary two-year terms, members are encouraged to coordinate assignments with the beginning and end of new projects—that lets assignees get in at the ground floor, not waste time looking for something to do, and it ensures that they take something of value back to the employer, says Squires. Sematech is also doing a re-entry study that tracks the careers of former assignees.

RATHER THAN fight the natural tendency to keep one's best people at home, MCC and Sematech are following SRC's lead by pushing much of their development work to member sites. That helps solve the personnel problem, encourages rapid transfer of technology, and promotes industry cooperation by forcing members to play host to suppliers and even competitors to work on areas of common interest.

"I agree with those who say that 'the best technology transfer is done by moving people,' " says MCC's Fields. He points to MCC's First Cities program, in which certain members are working to deliver interactive, multimedia communications to 200,000 sites around the nation by mid-decade. "We have very few MCC employees working on this and very little MCC money is involved, but it's generating a lot of excitement with members. Frankly, that's a great way for consortia to work—let the work be coordinated by the consortia but done by members." □

CONSORTIA

Start-up no more, Jessi gets down to business

Europe's chip consortium has met its early goals but now must cope with internal squabbling and radical cuts in government funding

By Barbara N. Berkman

In both structure and purpose, there exist vast differences between the Joint European Submicron Silicon Initiative (Jessi) and Sematech, its U.S. counterpart. Founded to make Europe more independent of U.S. and Japanese semiconductor and production equipment suppliers, Jessi is more democratic than Sematech—there is no membership fee, and small companies abound among Jessi's 150 research facilities. And despite persistent funding shortages, which one Jessi source says affects 80% of the projects, the consortium seems to be weathering the kind of internal squabbling that has plagued Sematech almost from its inception.

Jessi was formed in 1989 to beef up Europe's semiconductor independence and accelerate research in submicron technology and manufacturing. As originally conceived, the consortium was to receive 25% of its budget from the European Community (EC), 25% from national governments, and 50% from industry.

The collaboration revolves around four subprograms:

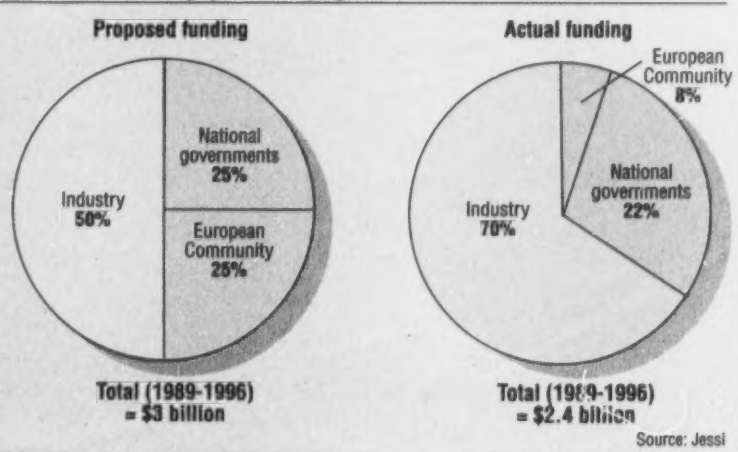
- Manufacturing and technology for engineering samples of 16-megabit and 64-Mbit DRAMS, 4-Mbit and 16-Mbit SRAMS, and EPROMs;
- Design and technology to shore up the presence of European materials, back-end processes, and production equipment in the world's fabs;
- The applications program, which encourages European CAD software;
- Basic and long-term research projects, including 0.25-micron CMOS technology, circuit design methodology, and lithography and other processing methods.

Specific results of Jessi aren't due until 1996, so any verdict on its progress is premature. Two years into the $2.4 billion program, however, Europe-based observers at most U.S. semiconductor companies are unimpressed. "We haven't seen a lot of activity from Jessi," says Daniel S. Lankford, chief executive of AT&T Microelectronics Europe. To be fair, though, Jessi is in fact just closing out its start-up phase. "The intention all along was to use that period to plan how we wanted to proceed," explains Klaus Knapp, Munich-based spokesman for the consortium. "It would have been impossible to do everything right away."

From that perspective, Jessi is only now getting under way. Several projects that had been run in parallel are now being rearranged into 15 new research "clusters," including HDTV, digital audio broadcasting, broadband communications, and other distinctly European applications. "On the main projects, such as the 64-Mbit DRAM, we're on time," says Knapp. Jessi also has produced the first silicon for 16-Mbit DRAMs (by Siemens), the first 16-Mbit EPROMs (by SGS-Microelectronics), design techniques for 0.7-micron logic chips, and equipment by ASM Lithography BV, based in Veldhoven, the Netherlands, to be used in a Jessi production unit.

Jessi certainly is not without its woes or its critics. For one thing, the consortium is hobbled by chronic

Industry picks up government's Jessi tab



Source: Jessi

funding shortages. The European Community has coughed up only $40 million—8% of Jessi's funding rather than 25%—and national governments have stinted on their commitments. The result is a budget that falls $600 million short of the original proposal. European electronics companies helped by kicking in 20% more than they had planned, but industry's coffers are clearly strapped: Hard economic times forced Philips Electronics to withdraw from Jessi's SRAM project last year, for example, although the company remained in 20 other programs.

Other projects also have been compromised by the deficit. By late 1990, the equipment/materials program had consumed three years of funding in only two years, effectively shutting the door on any new proposals. Basic and long-term research "received a very small fraction of the [budgeted] money," says program chairman Ronald A. Lawes. That forced a halt to one of its most important projects, 0.25-micron CMOS research. In another program, Siemens Nixdorf Information Systems is footing its own bill in a CAD project for PCB design after funding by the German government fizzled.

Jessi's achievements ...

Since its 1989 start-up, the consortium's members have:

- Released first silicon for 16-Mbit DRAMs, 16-Mbit EPROMs
- Approved 0.7-micron production technology
- Developed first 0.25-micron structures
- Introduced CAD frame system for automated chip and board design

... and ambitious goals

By 1996, Jessi plans to:

- Launch 0.5-micron pilot production
- Produce first 0.3-micron silicon and engineering samples
- 0.3-micron pilot production during 1996
- Equipment prototyping and verification for 0.3-micron process

Source: Jessi

Jessi's critics also charge that the consortium is being weakened by the growing interdependence of members in other types of alliances. The DRAM agreement between Siemens and IBM created a political uproar at Jessi, for example, although others see that alliance as a way to conserve Jessi's resources by tapping IBM's expertise in X-ray lithography. "Jessi was never intended as the one and only [form of] cooperation," says Erik Kamerbeek, chairman of Jessi's equipment program.

Jessi certainly is not without its woes or its critics. For one thing, it is hobbled by chronic funding shortages

Others claim that Jessi's technological advances are being compromised by political xenophobia that makes no commercial sense. Anti-Japanese protectionism led Jessi to eject ICL Ltd. from three of five CAD projects after the British computer maker was bought by Fujitsu Ltd. Jessi labeled ICL "foreign-owned," even though IBM Europe was allowed into two Jessi projects.

The consortium has paid off for many of its member companies. For example, Jessi membership releases up to $1.3 billion in British government funding to Britain's Racal-Redac during the first 18 months of a five-year CAD project to develop design tools for complex boards.

"Without the money, we might have gone in that direction, but we wouldn't have progressed as fast," says Roy Davies, who heads Racal-Redac's participation in this CAD project. He estimates the Jessi membership means Racal will commercialize the tools 30% to 50% faster than if it had proceeded alone. Jessi's joint-research structure gives Racal the elbow room to take more risks in development, he adds, and provides a forum for bringing European users into the development process.

ASM Lithography also has benefited from Jessi, particularly from the consortium's emphasis on bringing together manufacturers and end-users in joint development. The company received its first order for a PAS 5500/90 deep UV wafer stepper and i-line system from IBM's German subsidiary, which will use the equipment in a Jessi project to test and improve a photolithography cluster tool for 0.35-micron processing.

The payoff for ASM Lithography consists of more than an order from IBM, however. The company also is counting on end-user feedback on the new stepper from other project members—including SGS-Thomson, Siemens, and Philips—so that it can fine-tune the equipment for the world market.

Yet to be seen, of course, is whether Jessi will give European companies a badly needed bigger share in the global chip and equipment market. For the near future, at least, most observers are doubtful—especially when it comes to equipment, which is heavily dominated by the U.S. and Japan. Siemens's semiconductor unit, for example, spends only 20% of its $200 million annual equipment budget on European equipment, compared with 55% on U.S. vendors and 25% on Japanese equipment.

The European equipment that Siemens does order is of relatively minor strategic importance, according to Winfried Ruttenauer, senior director of manufacturing engineering at the Semiconductor Group. Jessi may one day change that, he adds, but not in the near future.

Given its funding and organizational shortcomings and the inevitable political and cultural clashes, it would be easy to dismiss Jessi as a serious competitor in world semiconductor technology. That would be a big mistake, warns Sematech spokesman Buddy Price in Austin. "Don't sell it short," he advises. "All you have to do is look at Airbus—the world's second-largest aircraft manufacturer—to see what European consortia can do when they put their minds to it." □

100 FASTEST GROWING COMPANIES

Is this any way to sell computers? Zeos thinks so

Hawking unglamorous but reliable machines by mail, plus nimble service, has made it 1991's fastest-growing electronics company

By H. Garrett DeYoung

If you're thinking about buying a new personal computer, chances are you've already set a few ground rules. One, the name on the box is unimportant—any PC is practically identical to any other PC of the same specs. Two, the purchase itself will be no more intimidating than ordering a pair of socks from the Lands' End catalog. And now that computer makers are treating the masses with a little respect, you demand that even the most vanilla PC comes with full service and support.

That kind of thinking is music to Greg Herrick's ears. As chairman and CEO of Zeos International Ltd. in St. Paul, Minn., Herrick has made the company one of the nation's top direct-mail vendors of high-performance Intel-based computers and workstations. From 1988 sales of a mere $11.8 million, Zeos revenue rocketed to $127 million in 1990 and $231 million in 1991; net earnings soared from $234,000 to $10.3 million during the three-year period. The company's average annual growth rate during the past five years now stands at 188.7%, putting Zeos at the top of ELECTRONIC BUSINESS's 1991 list of fastest-growing companies.

To some degree, Zeos has prospered by acknowledging—indeed, touting—a basic weakness in the PC marketplace: The products have become not just commodities but "disposables," argues Joan Lappin, president of Gramercy Capital Management Corp. in New York. Marketing gimmicks notwithstanding, the distinctions between one computer and another are all but invisible thanks to rapid technological advances, intense domestic and foreign competition, and free-falling price-tags. Today's savvy users "don't need an IBM logo on the machine," says Herrick. As the mystique fades, he adds, buyers see mail order as a safe, convenient alternative to traditional channels.

Steve Wolf

"We need to work more on the repeat sales that account for up to half our business," says Zeos CEO Gregory E. Herrick

No one knows, of course, whether Zeos can maintain its frantic growth rate or for how long. For one thing, Herrick admits that margins are being squeezed by price-cutting and heavy mail-order competition—not only from players such as $890 million Dell Computer (25th on this year's fastest-growing list), Northgate Computer Systems, and Gateway 2000, but also from heavyweights IBM and Compaq. For another, a few rough spots lately suggest that Zeos may be trying to do too much too soon.

For now, customers fairly leap at the chance to gush the company's praises. "I've been very happy with Zeos equipment," beams Lappin, a recent convert from AST Research. "If they told me about a new product I could use, I wouldn't hesitate to send off a check." Industry analyst Clint Morrison, vice president and senior research analyst at John G. Kinnard & Co. in Minneapolis, is no

less glowing. "[Direct mail] is the most cost-effective way of getting computers into the customer's hands," he says. "Zeos is at the top end in terms of product quality and customer service—there's no question that the company will continue as a major player."

Zeos was launched in 1981 as a producer of radio transmitters for real-estate agents. When that business was sold in 1985, the founders turned to computer production to take advantage of their expertise in parts distribution and contract manufacturing of motherboards for Intel-based computers. The company now has an electronic-design subsidiary (PC Tech, acquired early this year) and a contract manufacturing unit, and distributes passive electronic components through a division dubbed Parts 1. Zeos went public in 1987.

If Zeos has a clear overall strategy, it seems to be simply to rapidly capture market share and establish its name before the direct-mail field gets too crowded. "People are getting into this simply because it's a proven strategy," says Herrick, who cut his direct-marketing teeth with Fingerhut Corp., the Hopkins, Minn.-based catalog retailer. Zeos hence relies heavily on multiple color ads in leading PC publications to get its competitively priced notebooks and 386 and 486 PCs into as many hands as possible. Herrick estimates that about 15% of the company's customers are home users, about 60% are small and midsize businesses, and some 5% are foreign buyers; the rest are distributed through government and academia.

Herrick and others realize that it takes more than convenience and low prices to win customers. "To be a player these days, you need really good machines," says analyst Morrison. So Zeos pushes its system upgradability, its use of big-name components—microprocessors from Intel, support chips from VLSI and Chips and Technologies, drives from Seagate and Conner Peripherals—and the more or less obligatory free software.

Buyers seem to be especially taken by Zeos's attention to basic marketing principles. Purchases may be charged to a major credit card or to Zeos's own revolving-credit card. Delivery is "very fast," according to Lappin, and Herrick promises to make it even faster. Beginning this year, he vows, all orders will be shipped within 48 hours; orders for standard configurations that are received by 1 PM will be shipped the same day.

The company also gets high marks for its customer support and service through a 24-hour toll-free number—the industry's first, according to Herrick—when problems do arise. "I can't think of a single case in which they didn't solve my problem," says Lappin. Adds Scott Uhrick, senior analyst at MBIA in Armonk, N.Y., "People ask me why I'm buying Zeos when I could buy from Hong Kong for $200 less. The reason is that I like their service on those occasions when something arrives broken." The 250-employee insurance company has bought about 120 Zeos PCs and notebooks during the past year.

Even with such rosy testimonials, Herrick says that Zeos could be doing some things better. One is to start targeting some of the company's advertising to previous customers. Those buyers now make up 30% to 50% of Zeos's current business, Herrick estimates, "even without promotion directed specifically to them." Also on the burner for Zeos this year is an organized push into international markets, where rival Dell Computer is much stronger. Herrick concedes that the company "hasn't made it easy for foreign customers to do business with us, but we wanted to be sure that everything was in place [in U.S. markets] before we take on overseas sales."

The idea that Zeos is setting its sights on new markets concerns some observers who wonder if the company isn't already struggling with the fairly minor, but still irritating, glitches that accompany rapid growth. Herrick says that production lagged demand briefly during last year's new-products transition, although he says the company rarely fell more than a week behind schedule. And money manager Lappin recalls a Zeos shipment that was lost for several days before it was delivered. "My impression was that they didn't have the people to track it down," she says. Herrick notes that such problems are now being addressed with new key personnel, a doubling of production capacity, and new telephone and MIS systems.

Analyst Morrison, meanwhile, has some qualms about Zeos's advertising and promotion expenses, which he says hit $9 million during the last quarter of 1991—12.7% of net sales. While Morrison credits Zeos for its aggressive spending in a soft market, "you also have to question the marginal effectiveness of those last few pages of advertising."

Unfazed, Herrick claims that the company simply can't afford to cut back on its marketing. He likens the PC business to the auto industry, in that everyone owns at least one. In such cases, market expansion is driven only by developing—and promoting—the features that set one product apart from another. Says Herrick, "It is these new features, such as pen-based systems and multimedia, that will keep this market growing for a long time." □

Zeos International at a glance

Fiscal year ended Dec. 31	1991	1990
Sales (thousands)	$230,913	$127,098
Net income (thousands)	$10,286	$4,205
Net income/ sales	4.5%	3.3%
Cost of sales/sales	76.2%	79.0%
R&D/sales	0.9%	0.2%
Marketing sales	12.3%	11.1%
G&A sales	3.8%	4.0%
Number of employees	744	549
Sales per employee	$310,367	$231,508
Net income per employee	$13,825	$7,659
Capital expenditures/sales	1.2%	1.4%
Current ratio	2.69	1.44
Debt/equity ratio	0.00	0.42

Source: Company reports

Electronic Business

Rank 1991	Rank 1990	Company Location	Five-year sales growth* (%)	Fiscal 1991 sales ($ millions)	Fiscal 1991 profits ($ millions)	Fiscal year ended	Industry segment
1	—	**Zeos International** St. Paul	188.7%	$230.9	$10.3	12/91	computers
2	—	**Sybase** Emeryville, Calif.	169.0	159.4	7.0	12/91	software
3	—	**SynOptics Communications** Santa Clara, Calif.	167.0	248.3	26.8	12/91	communications
4	—	**Brooktree** San Diego	117.8	83.4	9.5	9/91	semiconductors
5	—	**Cabletron Systems** Rochester, N.H.	115.8	180.5	35.9	2/91	communications
6	—	**Advanced Logic Research** Irvine, Calif.	109.1	228.0	14.7	9/91	computers
7	—	**American Power Conversion** West Kingston, R.I.	106.4	93.6	15.5	12/91	components
8	—	**Read-Rite** Milpitas, Calif.	103.4	177.0	23.1	9/91	components
9	—	**Altera** San Jose	99.4	106.9	17.8	12/91	semiconductors
10	—	**Encore Computer** Fort Lauderdale, Fla.	99.3**	150.0**	NA	12/91	computers
11	—	**Atmel** San Jose	90.5	120.4	10.3	12/91	semiconductors
12	—	**MIPS Computer Systems** Sunnyvale, Calif.	84.5	168.5	-34.7	12/91	computers
13	—	**Digital Microwave** San Jose	81.8	136.0	3.8	3/91	communications
14	—	**Knowledgeware** Atlanta	80.9	124.3	15.3	6/91	software
15	3	**Oracle Systems** Redwood Shores, Calif.	79.4	1,027.9	-12.4	5/91	software
16	—	**Chips and Technologies** San Jose	77.7	225.1	-9.6	6/91	semiconductors
17	6	**Octel Communications** Milpitas, Calif.	74.5	160.3	17.7	6/91	communications
18	8	**Sun Microsystems** Mountain View, Calif.	72.6	3,221.0	190.0	6/91	computers
19	1	**Teradata** Los Angeles	71.8	257.8	-2.4	6/91	computers
20	—	**Adobe Systems** Mountain View, Calif.	70.3	229.7	51.6	11/91	software
21	4	**Komag** Milpitas, Calif.	70.2	279.2	17.2	12/91	peripherals
22	—	**Aldus** Seattle	69.3	167.5	23.8	12/91	software
23	10	**Symbol Technologies** Bohemia, N.Y.	69.0	319.4	22.8	12/91	computer-based systems
24	9	**Silicon Graphics** Mountain View, Calif.	67.7	549.9	32.9	6/91	computers
25	11	**Dell Computer** Austin	66.5	889.9	50.9	1/92	computers
26	—	**Sierra Semiconductor** San Jose	62.0	85.9	13.1	12/91	semiconductors
27	13	**Cadence Design Systems** San Jose	61.5	392.3	-21.7	12/91	software
28	—	**Symantec** Cupertino, Calif.	60.8	116.3	9.4	3/91	software
29	2	**Sequent Computer Systems** Beaverton, Ore.	60.5	213.3	-48.7	12/91	computers
30	20	**Maxtor** San Jose	56.4	871.3	-45.4	3/91	peripherals
31	22	**Microsoft** Redmond, Wash.	56.3	1,843.4	462.7	6/91	software
32	—	**System Software Associates** Chicago	55.9	149.1	16.7	10/91	software
33	41	**Micron Technology** Boise, Idaho	54.2	425.4	5.1	8/91	semiconductors
34	38	**Silicon Valley Group** San Jose	53.2	234.8	1.6	9/91	semi equipment
35	5	**Dallas Semiconductor** Dallas	51.1	103.8	14.7	12/91	semiconductors
36	17	**BMC Software** Sugar Land, Tex.	50.6	139.5	31.4	3/91	software
37	—	**Landmark Graphics** Houston	50.3	89.9	9.8	6/91	computer-based systems
38	18	**Borland International** Scotts Valley, Calif.	50.2	226.8	26.8	3/91	software
39	23	**Vishay Intertechnology** Malvern, Pa.	49.8	442.3	20.9	12/91	components
40	49	**Quantum** Milpitas, Calif.	48.6	877.7	73.9	3/91	peripherals
41	—	**Everex Systems** Fremont, Calif.	46.3	425.1	-48.0	7/91	peripherals, computers
42	54	**Solectron** San Jose	44.6	265.4	9.2	8/91	contract manufacturing
43	—	**Electronic Arts** San Mateo, Calif.	43.7	101.8	9.1	3/91	software
44	—	**VeriFone** Redwood City, Calif.	43.2	187.9	18.7	12/91	computer-based systems
45	—	**Plexus** Neenah, Wisc.	43.0	120.4	3.6	9/91	contract manufacturing
46	15	**Seagate Technology** Scotts Valley, Calif.	42.2	2,677.0	62.8	6/91	peripherals
47	14	**Cypress Semiconductor** San Jose	41.3	286.8	34.2	12/91	semiconductors
48	21	**Novell** Provo, Utah	39.8	640.1	162.5	10/91	software
49	—	**Acuson** Mountain View, Calif.	39.3	336.3	58.5	12/91	medical
50	26	**Compaq Computer** Houston	39.2	3,271.4	130.9	12/91	computers

* Compounded average annual growth rate (1986-1991) ** Estimate NA=Not available

Electronic Business

Rank 1991	Rank 1990	Company	Location	Five-year sales growth* (%)	Fiscal 1991 sales ($ millions)	Fiscal 1991 profits ($ millions)	Fiscal year ended	Industry segment
51	—	**Autodesk**	Sausalito, Calif.	39.2%	$274.0	$57.8	1/92	software
52	33	**Pyramid Technology**	Mountain View, Calif.	39.2	227.9	12.0	9/91	computers
53	25	**Concurrent Computer**	Tinton Falls, N.J.	38.0	254.9	-66.8	6/91	computers
54	24	**Informix**	Menlo Park, Calif.	37.8	179.8	12.2	12/91	software
55	12	**Convex Computer**	Richardson, Tex.	37.6	198.1	-6.9	12/91	computers
56	—	**Proteon**	Westborough, Mass.	37.3	94.7	6.0	12/91	communications
57	36	**Tandon**	Chatsworth, Calif.	35.8	461.4	-48.0	12/91	computers
58	67	**ASK Computer Systems**	Mountain View, Calif.	35.2	343.9	2.7	6/91	software
59	16	**Interleaf**	Waltham, Mass.	35.2	84.3	-1.3	3/91	software
60	35	**Archive**	Costa Mesa, Calif.	34.4	345.6	-49.3	9/91	peripherals
61	51	**Applied Materials**	Santa Clara, Calif.	33.7	638.6	26.2	10/91	semi equipment
62	27	**3Com**	Santa Clara, Calif.	33.5	398.6	-27.7	5/91	communications
63	—	**Linear Technology**	Milpitas, Calif.	33.3	94.2	16.9	6/91	semiconductors
64	19	**FileNet**	Costa Mesa, Calif.	33.2	122.5	8.1	12/91	computer-based systems
65	—	**Qume**	Milpitas, Calif.	33.1	217.5	-19.6	2/91	peripherals
66	28	**Rexon**	Manhattan Beach, Calif.	33.0	183.0	10.8	9/91	peripherals
67	45	**Anthem Electronics**	San Jose	32.1	419.6	23.3	12/91	distribution
68	29	**Adaptec**	Milpitas, Calif.	32.1	128.9	12.2	3/91	peripherals
69	47	**AST Research**	Irvine, Calif.	31.9	688.5	64.7	6/91	computers
70	—	**Goal Systems International**	Columbus, Ohio	31.6	127.8	10.2	1/92	software
71	—	**Legent**	Vienna, Va.	30.5	203.3	33.9	9/91	software
72	62	**Intel**	Santa Clara, Calif.	30.4	4,778.6	818.6	12/91	semiconductors
73	43	**VLSI Technology**	San Jose	29.9	413.4	9.9	12/91	semiconductors
74	37	**Stratus Computer**	Marlborough, Mass.	29.2	448.6	49.7	12/91	computers
75	39	**LSI Logic**	Milpitas, Calif.	29.2	697.8	8.3	12/91	semiconductors
76	55	**Applied Magnetics**	Goleta, Calif.	28.9	455.5	-18.3	9/91	components
77	34	**EMC**	Hopkinton, Mass.	28.4	232.4	13.0	12/91	peripherals
78	—	**Nellcor**	Hayward, Calif.	28.0	158.9	16.3	6/91	medical
79	32	**Integrated Device Technology**	Santa Clara, Calif.	28.0	198.6	1.2	3/91	semiconductors
80	60	**Apple Computer**	Cupertino, Calif.	27.1	6,308.0	309.8	9/91	computers
81	31	**Western Digital**	Irvine, Calif.	26.8	986.2	-134.2	6/91	semiconductors, peripherals
82	—	**Nichols Research**	Huntsville, Ala.	26.7	91.5	4.7	8/91	government
83	42	**QMS**	Mobile, Ala.	26.3	304.3	18.1	9/91	peripherals
84	70	**Loral**	New York	26.2	2,126.8	90.4	3/91	government
85	40	**Applied Biosystems**	Foster City, Calif.	25.9	163.9	-2.8	6/91	medical
86	—	**CMS Enhancements**	Irvine, Calif.	25.9	130.1	-8.5	6/91	peripherals
87	83	**LAM Research**	Fremont, Calif.	25.2	144.0	6.1	6/91	semi process equipment
88	75	**Hutchinson Technology**	Hutchinson, Minn.	24.9	143.3	4.5	9/91	components
89	56	**Lotus Development**	Cambridge, Mass.	24.0	828.9	43.1	12/91	software
90	76	**Sensormatic Electronics**	Deerfield Beach, Fla.	23.9	239.2	24.7	5/91	computer-based systems
91	—	**Roole and Babbage**	Sunnyvale, Calif.	23.7	98.6	-11.0	9/91	software
92	—	**Structural Dynamics Research**	Milford, Ohio	23.2	146.3	17.9	12/91	software
93	—	**American Software**	Atlanta	21.6	101.9	17.5	4/91	software
94	30	**Computer Associates Int'l**	Garden City, N.Y.	21.5	1,348.2	159.3	3/91	software
95	78	**Medtronic**	Minneapolis	19.9	1,021.4	133.4	4/91	medical
96	58	**Tandem Computers**	Cupertino, Calif.	19.8	1,922.2	35.2	9/91	computers
97	48	**Data Switch**	Shelton, Conn.	19.6	103.0	-32.8	12/91	components
98	53	**Inmac**	Santa Clara, Calif.	19.5	302.8	6.8	7/91	communications
99	74	**Molex**	Lisle, Ill.	19.4	709.0	64.6	6/91	components
100	64	**BancTec**	Dallas	19.2	183.8	10.7	3/91	computer-based systems

* Compounded average annual growth rate (1986-1991)

Source: ELECTRONIC BUSINESS

FASTEST GROWING COMPANIES

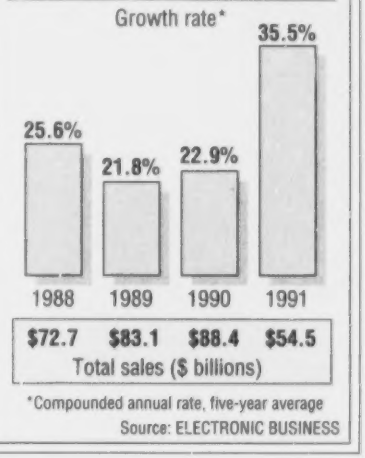
Brace for the next wave of hot young companies

The top 14 are new to the list—part of a 38% turnover. Recession felled the old guard while IPOs helped newcomers

By Linda Stallmann and E. B. Baatz

THE 100 fastest-growing companies together grew at a compounded average annual rate of 35.5% during the past five years, more than 10 points faster than the companies that made up last year's list. The faster growth was due to the addition of a multitude of smaller companies to the list (some of which just went public in the past year). Total 1991 revenues of the 100 companies came to only $54.5 billion, nearly $34 billion less than 1990's list. This rise in the number of small companies on the list indicates a significant shift in the demographics of the industry as a whole. □

The top 100 at a glance



*Compounded annual rate, five-year average

Source: ELECTRONIC BUSINESS

Companies that just missed this year's title

1991 sales ($ millions)

Acclaim Entertainment	$122.1	Micronics Computers	$133.9
Cisco Systems	183.2	Novellus Systems	80.0
Conner Peripherals	1,599.0	Radius	118.6
Exabyte	234.1	Cirrus Logic	141.8
Executone Info Systems	266.6	Xilinx	97.6

Source: ELECTRONIC BUSINESS

COMPANIES must meet several criteria to be eligible for the ELECTRONIC BUSINESS fastest-growing list. Companies are ranked by five-year compounded average annual sales growth and must have more than $1 million of revenue in the base year of 1986 and at least $80 million in 1991. They must be U.S.-based, publicly held, and receive at least half their revenues from electronics. Several that performed well last year failed to meet those criteria and so didn't make our list. Some, however, shape up as strong contenders for next year. □

Novell tops this year's list in profits

Company	Profits as % of sales	Profits ($ millions)	Rank
Novell	25.4%	$163	48
Microsoft	25.1	463	31
BMC Software	22.5	31	36
Adobe Systems	22.5	52	20
Autodesk	21.1	58	51
Cabletron Systems	19.9	36	5
Linear Technology	18.0	17	63
Acuson	17.4	59	49
American Software	17.2	18	93
Intel	17.1	819	72

Source: ELECTRONIC BUSINESS

RAPID revenue growth doesn't ensure profits. In fact, about one-fifth of the 100 companies on this year's list *lost* money in 1991. The best performers (measured by profits as a percentage of sales) were Novell, Microsoft, and BMC Software—all software companies with low overhead costs. Top profit makers as measured by sheer dollars are Intel ($819 million) and Microsoft ($463 million). □

THIRTY-EIGHT new companies joined the fastest-growing list in 1991. The 14 fastest-growing, in fact, are all newcomers, including Zeos International, Cabletron Systems, American Power Conversion, and Encore Computer. At the same time, several billion-dollar-plus companies—including Hewlett-Packard, Motorola, and Unisys—dropped off the list due to slow growth over the past five years. Amdahl, Intergraph, and SCI Systems were also pushed off the fastest-growing list by smaller companies. □

New arrivals to the fastest-growing list

The 1991 billion-dollar club

Company	Sales ($ billions)	Growth rate*	Rank
Apple Computer	$6.31	27.1%	80
Intel	4.78	30.4	72
Compaq Computer	3.27	39.2	50
Sun Microsystems	3.22	72.6	18
Seagate Technology	2.68	42.2	46
Loral	2.13	26.2	84
Tandem Computers	1.92	19.8	96
Microsoft	1.84	56.3	31
Computer Associates	1.35	21.5	94
Oracle Systems	1.03	79.4	15
Medtronic	1.02	19.9	95

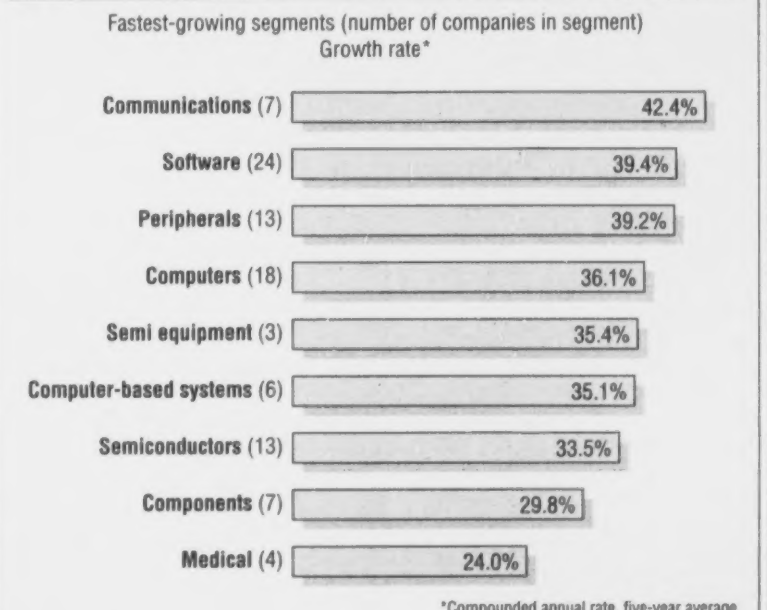
Drop-outs from the billion-dollar club

Hewlett-Packard	$14.49	15.3%	—
Motorola	11.34	13.9	—
Unisys	8.70	3.2	—
Amdahl	1.70	12.0	—
Intergraph	1.20	14.6	—
SCI Systems	1.13	19.1	—
Western Digital	0.99	26.8	81

*Compounded annual rate, five-year average
Source: ELECTRONIC BUSINESS

LAST YEAR'S fastest-growing list included 16 electronics companies with more than $1 billion in revenue; only 11 companies hold that distinction this time around. Both Oracle Systems and Medtronic grew their way into the billion-dollar club by just barely clearing the hurdle last year. Western Digital, which still clings to the bottom of the 100 fastest-growing list thanks to fast growth in earlier years, lost revenue in 1991 and so dropped out of the billion-dollar club. □

Communications and software pace industry growth



MOST INDUSTRY segments represented by the 100 fastest-growing companies grew much faster between 1986 and 1991 than between 1985 and 1990, but seven companies drove the communications segment to new heights. Synoptics, Cabletron Systems, and Digital Microwave paced the group and brought the communications sector to a five-year growth rate of 42.4%, up from 26.2% last year. Software also soared. With 24 software companies on this year's listing (versus 15 last year), the segment grew at a five-year pace of 39.4%, about the same as last year.

Some industry segments have become extinct in the fastest-growing ranks. Last year, 11 instruments, distribution, and military/government-related companies made the list. Only Anthem Electronics carries the 1991 distribution banner, and government-related business is represented solely by newcomer Nichols Research and old-timer Loral. □

What's really inside Japanese annual reports

New data reveals the extent of the lean operating style at Sony, Matsushita, Hitachi, and other leading Japanese electronics companies

By Paula Doe

Part II

Profits at major Japanese electronics companies may have tumbled or evaporated during the past year, but U.S. companies still face a formidable challenge from Sony, Toshiba, Hitachi, Matsushita, and the rest. Recent data from Japan reveal that the world's electronics juggernaut retains a powerful edge over its U.S. rivals in terms of productivity, administrative expenses, and organizational efficiencies.

You can forget the standard rebuttal by U.S. executives that the productivity gap—average sales per employee for the top 10 Japanese companies was $218,900 versus $135,600 for the top 10 U.S. companies in fiscal 1990—is a fluke of subcontracting or Japanese companies' use of subsidiaries. ELECTRONIC BUSINESS's analysis of the 1990 Japanese-language reports on corporate financials, released by Japan's Ministry of Finance (MOF), found that the average Japanese company's value-added per employee was almost twice that of the U.S. median—about $85,000 for the 10 largest Japanese companies versus $43,600 for 383 U.S. companies surveyed by the American Electronics Association. (Value-added per employee is a common measure of productivity that eliminates the effects of subcontracting and subsidiaries.) Comparing a median can be risky, and the AEA companies are much smaller than the Japanese companies, but these statistical fine points only partly explain the disparity.

The $85,000 figure was calculated by subtracting outside purchases of goods and materials from sales. This figure will be a little on the high side, since it still includes outside purchases of such items as utilities and supplies and services used in sales and administration, and doesn't include these costs on overhead, but it provides a reasonable picture of worker output at the parent company. Value-added per employee at the top 10 Japanese electronics companies averages a whopping $168,900, about 39% of total sales.

That's still artificially high, however, since only parent company

data is available. Applying the 39% value-added figure to consolidated sales per employee suggests an average output per worker of around $85,000 at top Japanese companies.

"Those are amazing numbers, but quite plausible," notes Maxwell Hall, a director of the Mountain View, Calif., office of the U.S. consulting firm Pittiglio Rabin Todd & McGrath (PRTM). He cites three reasons for the gap: the high automation levels at Japanese electronics companies, the capital intensity of their semiconductor fabrication, and their lower managerial overhead.

Lavish spending on research, production, and test equipment adds to Japanese worker productivity. Total consolidated depreciated fixed assets per employee in 1990 were $76,000 at NEC, $48,900 at Toshiba, and $39,000 at Matsushita. While IBM's fixed assets per employee came in at $72,873 in 1990, three other leading U.S. companies ran only about half that: Motorola ran at $35,981, Hewlett-Packard at $34,793, and Digital Equipment at $31,194. U.S. electronics companies in the AEA survey had an even weaker median investment per worker—$11,500—although there's a broad range based on type of company. Semiconductor companies' $20,560 per worker ran at the high end, while makers of peripherals and electronic production equipment came in at less than $10,000.

THE LOWER LEVELS of administrative staffing in Japan also is striking. Despite the common U.S. view of Japanese companies as huge bureaucracies, NEC, Hitachi, Fujitsu, and others actually have lower selling, general, and administrative (SG&A) costs than their U.S. counterparts. On average, consolidated SG&A, including R&D, came to 26.5% of sales in 1990, according to the MOF. The AEA sets the corresponding figure for smaller U.S. companies at 42%. Larger companies are not far off that mark: IBM spent about 40% of revenue on SG&A R&D in 1990, DEC about 43%, and Hewlett-Packard about 39.8%.

Is the disparity due to a different approach to marketing and advertising? Yes and no. Major Japanese companies spent about 12% of total sales for marketing, versus 18% for U.S. electronics companies, according to the AEA survey. (These figures are for the parent company only and don't include additional marketing by the companies' subsidiaries.) "Marketing and related costs are a lot higher in the U.S.," explains Kevin Jones of McKinsey & Co. in Tokyo. "The whole infrastructure for brand development is less in Japan."

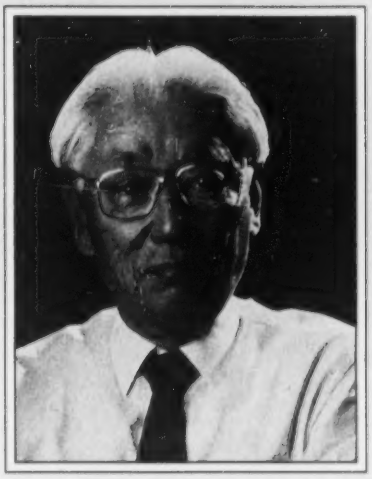
While general marketing spending is less, spending on advertising appears to be similar. Hardware companies in the U.S. spent about 1% of sales on advertising, according to the AEA, although makers of peripherals and office and consumer products spent about 2%. The big Japanese companies spent about 1.4%. Computer makers such as Fujitsu spent 1% and consumer companies such as Sharp spent 2.7%.

The real difference in SG&A doesn't lie in marketing costs but in the low administrative costs within Japanese electronics companies. Of the 21 cents on average that those companies spent on SG&A in 1990 for each $1 of revenue on an unconsolidated basis, about 12 cents went for sales costs, and less than 10 cents for general administration, including R&D. By comparison, the companies in the AEA survey reported median general administrative costs of 11.4% of revenue, *not* including R&D. Experts say the differences are due to Japanese companies' smaller corporate staffs, lower pay scales, and a longer work week. Japanese manufacturing put in an average of 2,124 hours in 1990, for example, 9% more than in the U.S., according to Japan's Ministry of

Sony's Morita urges higher pay, fewer hours for Japanese workers

THREE MONTHS AGO, Sony Corp. chairman Akio Morita created a stir by arguing that Japanese companies have been exploiting their workers and the community and would have to change. Morita claimed that Japanese companies have consistently made things cheaper than their U.S. or European rivals largely because of "the wide gap between working hours and salary levels between Japan and the U.S. and Europe."

The outspoken Sony founder's essay—"Japanese Style Management in Crisis: Why High Quality, Low Cost Manufacturing is criticized by the U.S. and Europe"—in the influential Japanese monthly *Bungei Shunju* struck a lot of nerves in Japan. Officials of the trade group Keidanren ranted publicly about the call for shorter hours and higher wages for workers just before the start of annual labor negotiations. But the prime minister reportedly telephoned Morita to express his praise for and agreement with Morita's views.



Caroline Parsons/Time Magazine

Will Morita's criticisms of Japan's workplace practices reduce productivity and close the price gap with Japan's competitors? Not dramatically and not soon

Morita's message apparently got through: The trade group recently approved a 10% reduction in work hours for Japanese employees. □

Labor. "They just run leaner," points out Daniel Maher, a partner of the Chuo/Coopers & Lybrand Consulting firm in Tokyo. "They use a very decentralized management structure."

It's not just a lean management structure, but efficient management techniques that distinguishes Japanese companies. "The rule of thumb in the U.S. electronics industry is a one-to-one ratio between the average number of direct and indirect laborers," notes Hall of PRTM. "In Japan, there's half an indirect labor person for every direct laborer, due to the efficiency techniques pioneered there." Japanese companies eschew warehousing parts, for example, using the point-of-use inventory technique that eliminates warehouse workers.

As for the salary gap, "the actual cost per person is lower," adds McKinsey's Jones. The Japanese companies spent an average of only 39 cents in 1990 for sales and administrative salaries and benefits (not counting central R&D) for each $1 spent on manufacturing labor. NEC spent 46 cents while Fujitsu spent only 31 cents. Unfortunately, the AEA survey did not include this type of data.

Note that the MOF numbers aren't absolute. Japanese reporting rules are more flexible than in the U.S., so particular ratios for a company or group of Japanese companies may vary considerably from those of their U.S. counterparts. More significantly, cost allocations are distorted due to the extensive use of subsidiaries and subcontractors. Some administrative costs are hidden as materials costs when components are purchased from subsidiaries or affiliates. Other costs get counted as cost of goods sold due to the decentralized organization of these companies. And some sales costs show up only as the discounted price at which goods are sold to sales subsidiaries or affiliates. Still, the overall trend

How do your costs stack up against Japan's?

Average costs, as percentage of revenue, for 10 major Japanese electronics companies

Cost of goods sold	
Materials	43.9
Labor	8.3
Overhead	10.7
Purchased goods	11.1
Total	74.0
Sales, general & administrative	
Sales	11.6
General & administrative*	9.8
Total	21.4
Operating income	4.6%

*Includes R&D

Source: Japanese Ministry of Finance

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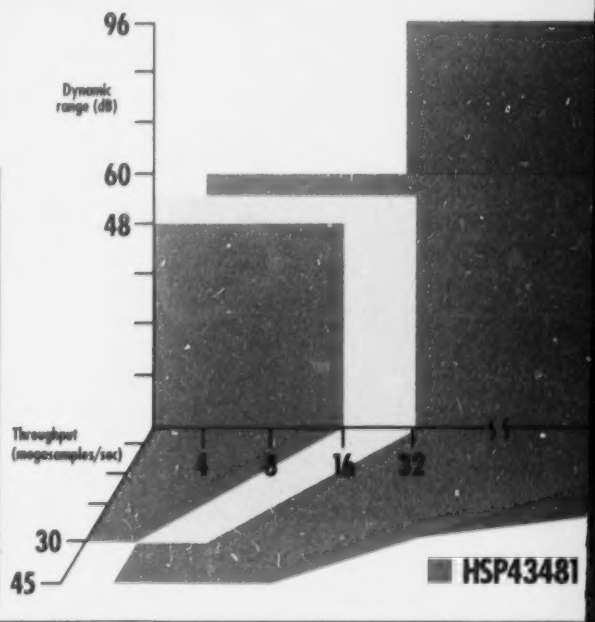

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is too big to be explained by accounting differences. These companies run lean.

ONE REASON is such management practices as just-in-time (JIT) inventory control. The dramatic impact relative to U.S. manufacturers can be seen in the MOF reports: The top Japanese companies report parts and materials inventories turnover in a matter of days, on a consolidated basis, while turnover rates at the smaller companies surveyed by the AEA may be measured in weeks. NEC reports turning over its components inventory every 11 days, Fujitsu every 10 days, Hitachi every 7 days, and Toshiba every 5 days. By contrast, the AEA survey found an average 51-day turnover rate, according to Peter Bearse, an economist and head of Development Strategies Corp. in Gloucester, Mass., who conducted the survey.

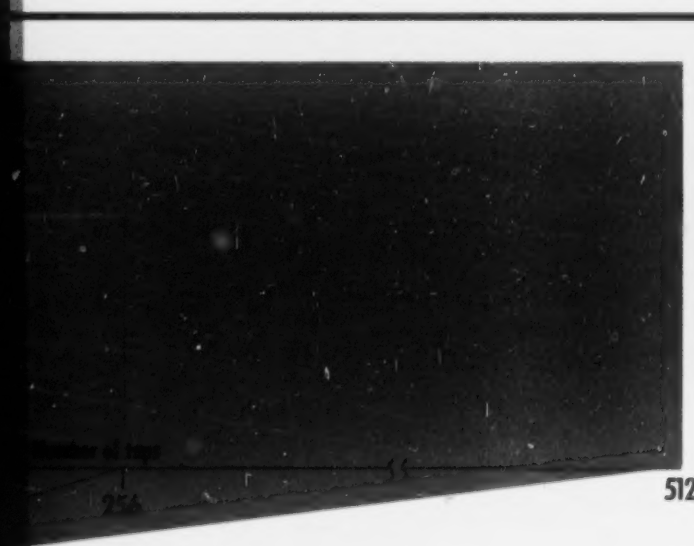
The result of this efficient manufacturing and lean overhead is that the Japanese can make money in consumer electronics in non-recessionary times, despite the influx of assemblers and copycats from Taiwan, Korea, and elsewhere.

Indeed, consumer electronics were more profitable for some companies than the supposedly higher-margin computer and telecommunications market, according to the MOF; margins in all sectors will be down sharply for the current year, however. Sony Corp. managed operating earnings of 8.4% of revenue on its consumer electronics business in fiscal 1990, while Matsushita Electric Industrial Co. made 6.8%. That's more than industry leaders NEC and Fujitsu earned from selling computers, components, and telecommunications gear. NEC earned only 5.8% on its sales, while Fujitsu showed a 6.6% margin. Matsushita also had slightly higher margins on its consumer business than in its own computer and communications business, where it earned 6.5%.

Japanese companies differ from their U.S. counterparts with smaller staffs, lower pay, and a longer work week

The diversified electric equipment suppliers Hitachi and Toshiba made fatter margins in their industrial electronics business. Hitachi achieved margins of only 1.2% in its consumer business, but a healthy 8.6% in computers and components. Toshiba managed a 2.8% margin in the consumer segment, but a 7.9% operating profit in computers and components.

The 1990 reports were the first ones to reflect a new requirement that Japanese companies disclose operating profits by business sector. Responding much as U.S. companies did to the introduction of similar U.S. rules some years ago, most of the major Japanese electronics companies lumped business units together to avoid revealing separate semiconductor and computer profit margins. And few reported earnings or even sales by geographic region as theoretically required. □



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FPGA market booms, but too many vendors could sink profits

Patent fights, price pressures, and the emergence of third-party tools will cull winners from losers

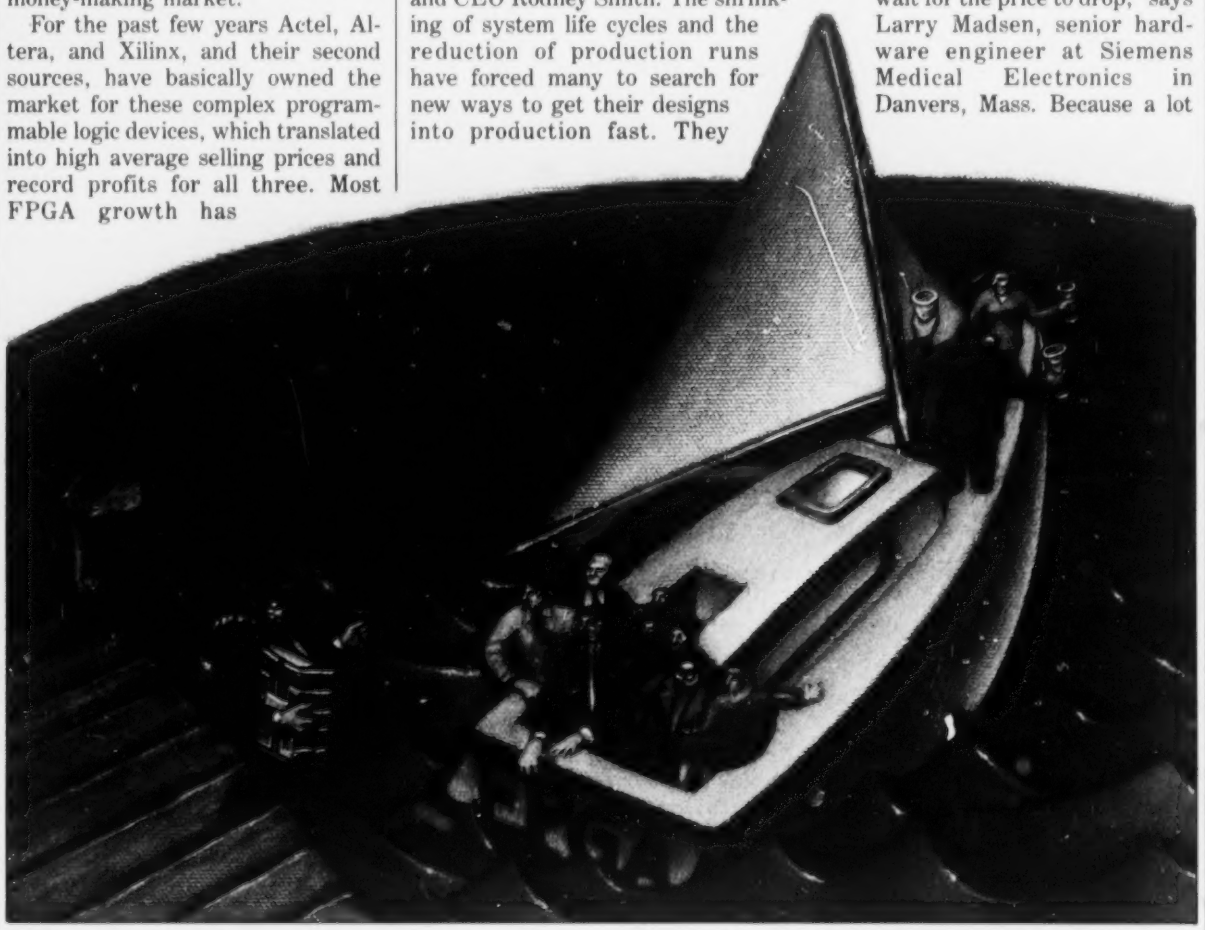
By Hugh G. Willett

As the field-programmable gate array (FPGA) market approaches its next stage of development, a rush of new profit-seeking vendors and the rise of universal design tools could signal the beginning of fierce competition in this so-far money-making market.

For the past few years Actel, Altera, and Xilinx, and their second sources, have basically owned the market for these complex programmable logic devices, which translated into high average selling prices and record profits for all three. Most FPGA growth has come from two quarters: those that integrate many low-end programmable logic devices (PLDs) into fewer FPGAs, and those that use FPGAs for prototyping gate arrays before moving into volume production.

"What we're really selling is time-to-market," says Altera chairman and CEO Rodney Smith. The shrinking of system life cycles and the reduction of production runs have forced many to search for new ways to get their designs into production fast. They worry less about marginal price differences and more about hitting profitable market windows. That emphasis is boosting FPGA sales not just for prototyping, but also for production, claims Smith.

Users agree. "We'd like to use FPGAs for all our designs, but we'll wait for the price to drop," says Larry Madsen, senior hardware engineer at Siemens Medical Electronics in Danvers, Mass. Because a lot



Jere Smith

of medical equipment is sold in low volumes, FPGAs are considered production solutions. In high-volume applications, however, gate arrays are still preferred, he says.

The complex PLD and FPGA market will grow from a still-small $186.7 million in 1991 to roughly $900 million by 1995, according to InStat, a Scottsdale, Calif.-based market research firm. "The FPGA market is just about ready for its next big growth spurt," says InStat analyst Rhondalee Rohleder. Although true gate array replacement accounted for less than 20% of the total FPGA market, many observers think FPGAs will capture an increasing share of that market as FPGA densities increase. That could transform the $3.5 billion gate array market—at least at the low end—into the most important source of new FPGA design wins. Low-cost mask-programmed parts from Xilinx and Altera are already easing the transition to high-volume production wins by lowering costs for users, Rohleder says.

It seems now that everyone wants a slice of the FPGA pie. In the past three years, at least a half dozen startups have entered the FPGA arena. The list of newcomers includes QuickLogic, Crosspoint Solutions, Concurrent Logic, Plus Logic, and Lattice Semiconductor. GEC Plessy and Algo-tronics, both from Britain, have stepped up to represent Europe in the FPGA sweepstakes.

"We've found a gap in the market big enough to drive a truck through," says Crosspoint Solutions' Vagit Arat

The barriers to entry for newcomers, however, are quite formidable. One significant barrier is the software tools required to design and program FPGAs. Altera, Xilinx, and Actel have sold, at a healthy profit, proprietary design environments that are not compatible with one another nor with the new upstart architectures. Indeed, tool sales, rather than silicon, have been important profit centers for these vendors. Users are not about to invest in new software and training on the promise of unproven technology, claims John East, president and CEO of Actel.

Siemens's Madsen, who uses the Actel parts, says the software issue is critical to the success of new architectures. "We don't want to invest in new design software," he confirms.

A potentially bigger obstacle to entry is the brewing patent battles between competing vendors. In fact, intellectual property has already surfaced as a thorn in the side of Actel. In March 1992, Xilinx filed suit in Federal District Court in California charging Actel with infringement of a broad patent—issued in 1989—which covers circuits with configurable logic elements and configurable interconnects. If the patent is upheld, other FPGA vendors could be targeted, says Bob Hinkley, vice president and general counsel at Xilinx. Actel's East denies infringement and points out that the Xilinx patent is under reissue, which clouds its validity. "I know how hard it was for us to overcome these barriers, and we were only two or three years behind Altera and Xilinx. I think it's going to be very difficult for a new vendor to get in now," East says.

Legal battles aside, both Altera's Smith and Actel's East claim the newer FPGA architectures will either fail or be absorbed by the larger players who can provide access to distribution and the already installed base. That Plus Logic, one of the first to follow the three leaders into the market, was recently acquired by Xilinx is offered as proof that the consolidation has already begun by Smith and East. Not surprisingly, the newcomers disagree. They're confident that the market wants and needs more choices.

The growth of third-party design automation tools from Viewlogic, Cadence, and Mentor has also sparked a mini-revolution from companies such as Data I/O, NeoCAD, and Exemplar, providing PLD- and FPGA-specific tool sets that promise to outperform the proprietary tools, says Vagit Arat, VP of marketing at Crosspoint Solutions in Santa Clara, Calif. "We've found a gap in the market big enough to drive a truck through," he proclaims. "We have produced a design kit that is transparent to the user."

Arat thinks that the biggest opportunities are in the CMOS ASIC market and says designers will want to use the same tools to design FPGAs that they use for gate array development. Crosspoint's fine-grained architecture is more like a gate array than any other FPGA offering. Using the same tools will permit users to avoid the added tool investment and a long learning curve, he claims.

The new architectures offer specific advantages that, while not replacing the existing architectures,

Who's using FPGAs?

Worldwide CMOS FPGA market demand ($ millions)

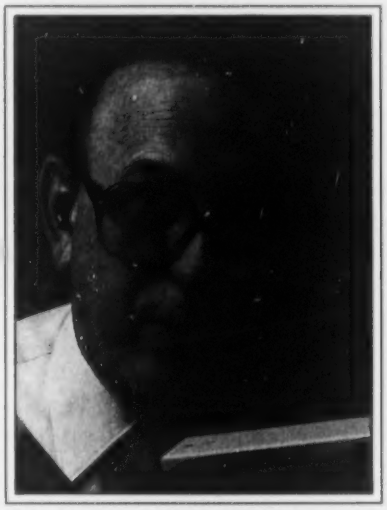
	1990 Consumption	1990 % market share	1995 Consumption	1995 % market share	1990-1995 CAGR
EDP	$43	40.0%	$178	32.5%	32.9%
Communication	24	22.5	156	28.5	45.4
Industrial	21	19.0	104	19.0	37.7
Consumer	2	1.5	8	1.5	32.0
Military	18	17.0	102	18.5	41.5
Automotive	0	0.0	0	0.0	NA

Source: In-Stat Inc.

can provide specific advantages for certain applications, says Joel Rosenberg, director of marketing at Concurrent Logic in San Jose. Concurrent's chips have more registers than competing architectures, making them better solutions for register-intensive applications for telecommunications and deep-state machines, he says.

As of yet, the new architectures have lived up to their claims, says Jim Christopherson, VP of engineering at Accutonics. It's just a matter of time before universal tool sets become good enough to make an impact, contends InStat's Rohleder. Accurate benchmark tests that will let a designer know just which part is best for the application is also needed. Thus far, speed and density claims have been exaggerated so much that designers must become proficient with architectures before they can compare them.

"By next year, universal tools will be superior to proprietary offerings," contends Larry Morrel, VP of marketing at Data I/O in Redmond, Wash. Ultimately, high-quality universal tool sets will enable a designer to concentrate on logic design and then look for the best performance and price among the devices available, says Morrel, and he predicts that such competition will lower prices, sparking fierce wars within two or three years.



John Kennard

"We'd like to use FPGAs for all our designs, but we'll wait for the price to drop," says Siemens's Larry Madsen

Price is definitely an important factor in the FPGA market. Actel recently reduced its prices down as much as 28% on its first- and second-generation parts. Xilinx has also lowered its prices, to less than $5 on some FPGAs, breaking the price barrier that existed when FPGAs were more than three times the cost of gate arrays.

With only a 3X differential with gate arrays, time-to-market advantages make FPGAs a viable option for production volumes, says Bob Zielke, director of marketing at Xilinx. "It has already become a manufacturing race instead of a design-win race," he says. "Most designers have chosen their architecture, and they're looking to use FPGAs instead of gate arrays." Crosspoint is not ignoring the cost question, Arat says. His company has signed several large, but as yet unnamed, Japanese chip makers to build its devices, ensuring that Crosspoint can compete on price with both gate arrays and other FPGA suppliers.

Third-party tool vendors agree that FPGAs will become less expensive as competition increases and transparent design is made possible. "Once the gate array customer could design a device independently, new suppliers came into the market, and prices fell," says Robert Anastasi, VP of marketing at NeoCAD in Colorado Springs, Colo.

Prices may drop, but the FPGA market will be better off in the long run, says Ewald Detjens, president of Exemplar Logic in Berkeley, Calif., which focuses on logic synthesis and sells its software to both proprietary FPGA vendors and the commercial market. Third-party suppliers specializing in particular niches can provide superior tools, he says. When better tools are available, performance and integration will increase, more gate array designs will be put into FPGAs, and the overall market for all the competing architectures will expand. □

Worldwide CMOS PLD end-market demand

($ millions)

	1990 Consumption	1990 % Market share	1995 Consumption	1995 % Market share	1990-1995 CAGR
Total CMOS PLD					
EDP	$159	51.5%	$339	32.5%	16.3%
Communication	67	21.8	235	28.5	28.5
Industrial	54	17.5	152	19.0	23.0
Consumer	3	1.0	8	1.5	21.7
Military	25	8.2	89	18.5	28.9
Automotive	0	0.0	0	0.0	NA
CMOS EPLD					
EDP	$63	36.8%	$103	28.8%	10.3%
Communication	36	21.0	100	28.0	22.7
Industrial	48	28.1	102	28.5	16.3
Consumer	2	1.0	3	1.1	8.4
Military	22	12.9	50	14.0	17.8
Automotive	0	0.0	0	0.0	NA
CMOS E²PLD					
EDP	$96	70.1%	$236	50.5%	19.7%
Communication	31	22.6	135	28.9	34.2
Industrial	6	4.4	50	10.7	52.8
Consumer	1	0.7	6	1.2	43.1
Military	3	2.2	39	8.3	67.0
Automotive	0	0.0	0	0.0	NA

Source: In-Stat Inc.

Notebook PC makers struggle to survive at "sub-survival" prices

Faced with dozens of competitors and fast-moving technology, vendors seek new product designs that won't break the R&D bank

By Rick Whiting

You can't buy notebook PCs from gumball machines. Not yet, anyway.

Notebook PCs began 1991 as specialty items and finished the year as commodities. As 150 or more vendors flooded the world market with nearly 2.3 million notebooks in 1991, prices eroded by 30%, 40%, or more. The price wars have only become hotter in the first half of 1992, and for notebook vendors the big challenge is differentiating their products enough to make any profit at all.

"And differentiation is hard to come by in this market," says Nassir Ahmed, notebook products marketing director at Texas Instruments Inc.'s peripheral products division in Temple, Tex.

Despite the inherent limits posed by notebooks' size, manufacturers are finding a variety of ways to make their products stand out in the crowd. Some are focusing on technological features—everything from data and fax modems to improved display screens to longer battery life. Other vendors are concentrating on service, distribution, and similar intangibles.

Worldwide sales of notebook PCs climbed from about $2.8 billion in 1990—the first year that notebooks really hit the market—to some $7.4 billion last year, according to InfoCorp in Santa Clara, Calif. And this year the market research firm expects vendors to sell some 3.4 million notebooks valued at $11.2 billion—exceeding sales of all other portable computers combined.

With this growth has come turmoil, however. Average selling prices for 286-based notebooks plunged 46% between the first quarter and the end of 1991, while prices for 386SX-based notebooks fell 35%, according to Sandra Gant, microsystems research vice president at InfoCorp. Notebooks using Intel Corp.'s newer 386SL microprocessor already have been cut to "survival" prices, says Michael A. Aymar, general manager of Intel's entry-level products group in Santa Clara, while notebooks with the SX chip are selling at "sub-survival" prices.

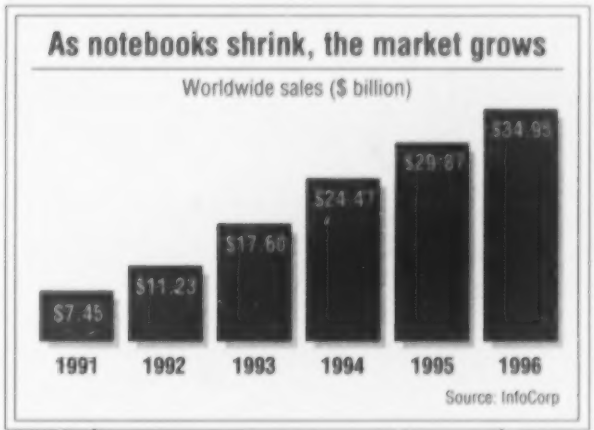
Grant Johnson, product marketing director with Toshiba America Information Systems Inc.: The rapid pace of technology in the notebook market "can kill a small company"

"If one vendor is slow to respond to changes in market pricing, we'll see a drop-off in demand," says Bruce Grant, technical services vice president with MicroAge Computer Centers Inc. in Tempe, Ariz., which resells most major brands of notebooks through value-added resellers and franchise dealers and directly to users. While top-of-the line notebooks carry price tags of $7,000 or more, most run in the $2,000 to $3,000 price range and low-end clones are selling for under $1,000.

The cutthroat competition has taken its toll on already-tight profit margins; one executive, who asks not to be identified, calls a 3% profit margin on a notebook PC "respectable." The strategy at many manufacturers is to keep prices low in order to quickly ramp up sales, rather than earning big margins on each notebook. "Volume is the key to making any money right now," says Sharon Colman, PC products manager at Hyundai Electronics America in San Jose.

The current goal for some vendors is not so much to make money off their products but to build and hold a user base, says Kevin Kilroy, marketing director for Samsung Electronics of America. Some

makers of low-priced clones may be selling notebooks below cost in a desperate attempt to gain market share, suspects Grant Johnson, product marketing director with Toshiba America Information Systems Inc. in Irvine, Calif. "Once you get past the top 10 vendors, it's hard to imagine companies surviving by selling [just] hundreds of units per month," he says.



The notebook PC market is relatively fragmented: By most counts, only Toshiba and Compaq Computer Corp. hold market shares in the double-digit range. Apple Computer Inc. is rapidly catching up with its PowerBook notebooks, introduced last fall. Other major players in the market include AST Research Inc., Texas Instruments, Tandy Corp.'s Grid Systems subsidiary, Dell Computer Corp., NEC, Zenith Data Systems, NCR Corp., and Sharp Electronics Corp.

Adding to the market glut are a slew of Taiwanese manufacturers selling low-priced notebook PCs based on a design developed last year by a government-led consortium of 46 companies. Sold under their own label or through OEMs, most of the Taiwan-made clones have few value-added features and, in some cases, says one observer, are of questionable quality. "And they can't keep pace with the technology," says Mike O'Dell, product development vice president at Dell, who estimates that Taiwan clones may lag U.S.- and Japanese-made notebooks by six to eight months.

Still, most observers do not expect an industry shakeout so much as a constant churning of smaller vendors dropping in and out of the market. Bruce Stephen, director of PC hardware research at International Data Corp. (IDC) in Framingham, Mass., says he discovers more notebook hawkers every week. One vendor in San Diego, he says, resells Taiwan clones and is all of five employees conducting sales and support by phone.

How can notebook PC manufacturers distinguish themselves from the rest of the pack? They must make their products as small and as light as possible with easy-to-use keyboards, high-resolution display screens, communications capabilities, large disk capacity, and batteries that last for hours—all at highly competitive prices. Vendors, in short, must design and build Mercedes-Benz sports cars and sell them at Yugo prices. "The trick is doing all this at the right price," Hyundai's Colman says of the balancing act.

Low-quality LCD screens have been the Achilles' heel of the notebook computer

Staying on the leading edge of technology is tough. "That can kill a small company," says Toshiba's Johnson. "Vendors have a narrow window on innovative technologies—they may have a good product at a good price, but in six months it's outdated." While most notebooks now use the 386SX chip, for example, that technology is becoming obseleteas more products based on the 386SL microprocessor hit the market. Specifically designed for notebooks, the 386SL is more tightly integrated to take up less space and offers a "sleep mode" to extend battery life. IDC's Stephen expects that most notebooks shipped will use the SL by year's end.

Speeding that transition is the SL's steadily decreasing price, which has fallen from $176 per chip in 1000-unit lots for the 20-megahertz version in October 1990 to $101 in the first quarter of this year. The newer 25-MHz version is priced at $122, cut from $178 in March.

A few notebooks using the 486DX chip, such as the Slimnote from Taiwan-based Twinhead Corp., are already on the market. But one competitor suggests that given the chip's higher cost, manufacturers that build notebooks with the 486 are seeking publicity more than sales. An SL version of the 486 chip is due by the end of this year.

The current 5-volt version of the 386SL chip will be replaced by a power-stingy 3.3-volt version by mid-year, says Intel's Aymar. Advanced Micro Devices Inc. began marketing its own 3.3-volt 386SL "work-alike" chip last October.

The downside of this improvement is that makers of ASICs and controllers for notebooks must redesign their components for a 3.3-volt world. And since the transition will not happen overnight, manufacturers such as Cirrus Logic Inc. are engineering products for mixed-voltage systems.

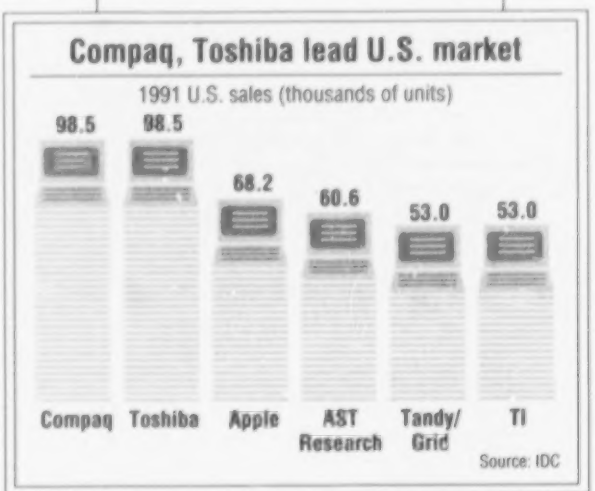
Longer battery life and better display screens are the twin holy grails for notebook manufacturers looking to stand out. Battery life ranges from one and one-half hours to four hours or more, depending on the computer's features and the battery technology (alkaline, nickel-cadmium, nickel-metal hydride, etc.).

Most notebooks today offer power management features to save juice, such as powering themselves down when the computer is on but not in use. Sharp is taking that idea a step further by designing notebooks with adjustable power consumption.

Low-quality LCD (liquid crystal display) screens have been the notebook's Achilles heel, but the improved LCDs used in most notebooks today are fueling the market's growth. Notebooks with color dis-

plays are just now hitting the market and vendors expect growing demand for color as more users add Microsoft Corp.'s Windows and other graphics-intensive software to their machines.

Some vendors are building notebooks with active matrix LCD screens, which offer better resolution than passive matrix screens or older technologies. Sharp's new PC-6881 notebook with a color active matrix LCD, for example, created a splash at the Lap & Palmtop trade show in New York in March. The downside is that color active matrix LCDs cost more ($1,250 to $1,500 or more, compared with about $750 for a color passive matrix LCD), and they are trickier to manufacture: Last month, for example, Epson America Inc. backed off a plan to market the NB-SL/25C color notebook, citing "quality issues" surrounding the computer's metal-insulated-metal active matrix LCD.



Graphics applications for notebooks are also boosting demand for more disk capacity, says MicroAge's Grant. He sees most manufacturers abandoning 40-megabyte disk drives in favor of drives with 70- and 80-Mbyte capacities to meet demand.

Because users buy notebooks to keep in touch with the home office as much as to do work on the road, data modems, fax modems, and other communications capabilities are fast becoming standard requirements. General Electric Co.'s international power systems operation in Schenectady, N.Y., which builds and maintains power plants worldwide, leases more than 300 Compaq notebooks for its field engineering and service staff. The computers' fax and electronic mail capabilities, which allow the troubleshooters to communicate with GE's factories and engineering, sales, and customer service departments, were a major factor in GE's brand choice, says decision support manager John Conroy.

Another differentiating feature is user configurability. Wyse Technology, for example, offers what it calls "personality modules" for its DecisionMate notebooks—cigarette package-size modems, serial ports, mouse pads, and other options that plug into the computer. Librex Computer Systems Inc., a San Jose-based subsidiary of Nippon Steel Co., trumpets its T386SX as "the ultimate configurable notebook" to which users can add 20-, 40-, and 80-Mbyte disk drives, memory cards or modems, "memory modules" of RAM, and other goodies. "But we know these are fleeting advantages," says Martin W. Brauns, Librex's marketing general manager.

To give their notebook computers flexibility, manufacturers are rapidly adopting the PCMCIA (PC Memory Card International Association) interface standard. Originally created to specify how credit-card-size memory cards plug into and work with portable computers, the PCMCIA specifications are now being used by notebook designers to provide connection slots for fax modems, add-in memory modules, and optional input/output devices. They are filling much the same role as the AT-bus slot in desktop PCs.

All this is creating a demand for components, subsystems, and other products that are small, tightly integrated, and consume little power, says Jim Chapman, marketing vice president at Cyrix Corp. in Richardson, Tex., which recently began producing math co-processor chips for notebook computers. Rockwell International Corp. has introduced an internal modem for notebooks that combines data, fax, and voice capabilities. And in February of this year, Intel and disk-drive maker Conner Peripherals Inc. teamed up to develop proprietary flash memory-based solid-state storage devices for notebook and handheld computers.

Beyond technology and price, vendors can leverage service and other extras to stand out from the pack. Wyse Technology's "Notebook Express" service program includes Federal Express pick-up and delivery and a 48-hour turnaround. Hyundai, meanwhile, has been offering a lifetime warranty on its notebooks on a trial basis. And for the environmentally aware, Compaq has started a battery-recycling program.

Given their thin profit margins, few vendors find direct sales to be a viable distribution option; distribution presents vendors with both a challenge and an opportunity to distinguish themselves from the crowd. Notebooks are a natural for the direct-mail sales strategies empioyed by Dell, Zeos, and Micro Express. Dell, based in Austin, uses a Pacific Rim contract manufacturer to assemble basic notebook computers, then configures each one in its Austin plant according to customer order.

More and more vendors are supplementing their standard dealer-chain sales by moving products through mass merchandise channels—computer superstores such as Dallas-based Comp USA, for example, and office supply chains such as Staples and BizMart.

Vendors are also hunting for value-added resellers who bundle notebooks with application software and sell to such niche customers as insurance claims adjusters and real estate agents.

And then there are always gumball machines . . . □

NOTE

ONLY THE FOLLOWING PAGES OF THIS PUBLICATION HAVE BEEN FILMED

Cov. 1, Pgs: 2, 3, 7, 8, 12, 29, 30, 34-38, 40, 42, 49, 50, 73-76, 103, 104, 106, 108, 110, 112, 114, 131-134, 140, 141, 145, 146, 148, 150, 153